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Innovation, Ownership and IPO Underpricing

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Dedication

To
My parents and grandparents

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I am deeply grateful to my advisers, Dr. Tarun K. Mukherjee and Dr. M. Kabir Hassan, in their fundamental role in my doctoral work. My advisers provided me research freedom, at the same time continuing to contribute valuable feedback, advice, guidance, and encouragement. I am also very thankful to other members on my committee for their guidance at different stages of my dissertation. Furthermore, I would like to express my appreciation to the University of New Orleans and to all my colleges for their support.

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Abstract

This dissertation consists of two empirical essays. The first chapter titled: "Hedge Fund Activism and Dual Ownership of U.S. Multinationals". Harford, Wang & Zhang (2017) conclude that holding high cash balances abroad to avoid US taxes causes internal capital markets and investments distortions. We posit that hedge funds target MNCs with more severe internal capital and agency problems. We demonstrate that upon acquiring dual ownership in these firms, hedge funds reduce internal capital problems and improve investment, especially innovation, efficiencies. To further reduce agency costs of foreign cash holdings, hedge funds engage dual firms in focused acquisitions. These improvements are reflected in superior performances of dual firms relative to non-dual firms. Chapter 2 titled as "Innovation Strategies & IPO Underpricing". In this chapter, we investigate how a firms' choice of pre-IPO innovation strategies affect IPO pricing. We differentiate the orientation of the issuing firm's innovation portfolio in terms of exploitative orientation versus explorative orientation based on citations of patents across technology classes. We introduce a measure of innovation power to generate breakthrough innovations. We show that the issuing firms with greater innovation power, especially firms with exploratory orientation of a patent, significantly decrease underpricing and have the power to bargain a higher offer price. Our results suggest that a higher exploration strategy requires more time to negotiate a higher offer price while more valuable innovation requires less time to bargain at the higher offer price.

Keywords: Dual Holders, Institutional Investor Activism, Innovation, Product Market Competition, Foreign Cash Innovation Strategy; Exploratory Innovation; Exploitative Innovation; Underpricing; Bargain Power

Chapter 1

Hedge Fund Activism and Dual Ownership of U.S. Multinationals

"BlackRock also engages to understand a company's priorities for investing for long-term growth, such as research, technology and, critically, employee development and long-term financial well-being…. If tax reform also includes some form of reduced taxation for repatriation of cash trapped overseas, BlackRock will be looking to companies' strategic frameworks for an explanation of whether they will bring cash back to the U.S., and if so, how they plan to use it. Will it be used simply for more share buybacks? Or is it a part of a capital plan that appropriately balances returning capital to shareholders with prudently investing for future growth?"

–Laurence Fink, CEO, BlackRock, 2017

I. Introduction

Empirical evidence generally supports the view that hedge fund activism creates value for shareholders by effectively influencing the governance, capital structure decisions, and operating performance of target firms (Brav et al. 2010). Brav et al. (2016) find that resulting from hedge fund activism, target firms experience increases in innovation output, measured by both patent counts and citations. They argue that the reallocation of innovative resources and the redeployment of human capital contribute to the refocusing of the scope of innovation. Alsan and Kumar (2016) show that hedge fund activism has negative impact on real and shareholder wealth of target's rivals and improves productivity and capital allocation of target.

If hedge funds are able to create long-term value of the target and improve innovation output (measured by patent counts and citations) by holding shares of the target firm, *what incentive do they have to simultaneously hold debt (dual ownership) of the same company?* Various explanations exist regarding why hedge funds hold dual ownerships. First, Bodnaruk and

Rossi, 2016 suggest that dual holders might accept lower premium in merger negotiations when they stand to gain more from appreciation of their bond stakes in the target. Second, Jiang, Li, and Shao (2010) argue that dual ownership mitigates shareholder-creditor conflicts and thereby lowers loan yield spreads. In a similar vein, Yang (2017) propose that institutional dual-holders can curb excessive risk taking (i.e., wealth transfer) by lowering shareholder-creditor conflicts.

Based on Harford, Wang and Zhang (2017) (hereafter HWZ), we posit in this paper that an additional motive of dual ownership is to provide capital to firms facing internal capital problems resulting from situations where MNCs hold a large amount of foreign cash holdings to avoid (reduce) repatriation tax cost. According to HWZ (2017), investors place a significant discount on a firm's foreign cash holdings, leading to disruptions in the internal capital market and resulting investment distortions (i.e., domestic underinvestment and overseas overinvestment). In this paper, we demonstrate that an equally important motive why less-regulated funds (hereafter, LRFs)[1], comprised mainly of hedge funds, acquire dual ownership (hereafter, DLOs) is to reduce capital market as well as investment inefficiencies resulting from foreign cash reserves. US multinational companies (MNCs) provide a perfect laboratory to test this proposition as these companies are known to accumulate a large cash balance abroad in order to avoid repatriation tax.

We propose that LRFs' motive in taking dual positions in the target firm is to bring about permanent improvements in these firms. In so doing, DLOs would first inject debt capital as a means to mitigate internal capital and investment distortions. Second, to further improve internal capital markets and investment efficiencies, DLOs would wrest control from the current management by adopting strategies (as suggested in the literature on hedge fund activism) that include a) reducing insider ownership, b) engaging in proxy contests and c) weakening anti-

[1] In this paper, we use the term "hedge funds" and "LRFs" interchangeably.

takeover provisions. Third, improved investment efficiencies will likely entail enhanced innovation efficiency (IE) (see Hirshleifer et al. 2013)[2]. Fourth, in efficiently addressing the agency problems associated with foreign cash holdings, DLOs will get affiliated firms involved in focused acquisitions. Finally, these combined efforts would have a positive impact on DLO-affiliated firm's future operating as well as marketing performances.

We hypothesize that 1) hedge funds systematically target those MNCs whose foreign cash balances are likely to exhibit the severest distortions in the internal capital markets, causing thereby potentially greater investment distortions; 2) upon acquiring the dual position, hedge funds gain control from the existing management by taking strategic steps that include reducing insider ownership, resorting to proxy contest and fighting anti-takeover provisions, 3) successful implementation of these tactics should lead to more efficient investment decisions, especially the innovation efficiencies of the dually-owned firms, 4) DLOs would engage dually-owned firms in acquiring targets that would bring about synergies, and 5) DLO-firms would experience better operating and market performances.

Our results are consistent with the hypotheses above. The firms in which less regulated institutions take dual positions are decidedly the ones with more severe internal capital problems. In the post-dual stage, the DLOs engage in tactics to take away control from the pre-dual management in their successful efforts to improve the target's investment as well as innovative efficiency (both at the parent and the foreign subsidiary level). Dually-owned MNCs are more likely than their non-dual counterparts to engage in and complete focused acquisitions abroad. We

[2] According to Hirshleifer et al. (2013), innovation efficiency, which is positively related to the future operating performance and stock returns, will improve by using current technological potential to explore new technologies and current technological capabilities to innovate products with higher quality and higher economic value.

find that the target's innovative efficiency is a good predictor of the future operating performance and the future stock returns. Overall, we show that DLOs mitigate internal capital problems by mobilizing the internal capital market and improving investment efficiencies of target MNCs.

II. Hypotheses Development

II.1. Identifying Targets

The MNCs are many and almost all of them carry heavy cash balance abroad to avoid repatriation tax. How do DLOs select their target from this universe? According to HWZ (2017), the higher the repatriation tax, borrowing costs and agency problems, the higher are the investment distortions. Thus, we propose the following hypothesis.

Hypothesis 1. DLOs would likely take dual position in MNCs which are more severely exposed to agency costs of foreign cash holdings.

II.2. Strategies to Reduce Control Exercised by Pre-Dual Management

Undertaking the dual positions is just the first step in the strategic scheme of DLOs. In their goal to reduce distortions in internal capital markets and investment efficiencies of targets, DLOs are likely to take actions to consolidate their power in order to forge a long-term investment efficiencies of target firms. Brav, Jiang and Kim (2010) find that hedge funds create value for shareholders by effectively influencing the corporate governance of target firms. The pertinent literature identifies the means adopted by DLOs to influence the governance mechanisms by gaining control from the existing management via a) elimination of insider trading, b) proxy contests for control, and c) removal of anti-takeover provisions.

Insider trading allows corporate insiders to exploit other investors (Porta et al. 2006 and Djankov et al. 2008). Companies with larger excess control rights of insiders are more financially constrained (Lin et al. 2011). Constraining corporate insiders by enforcing insider trading laws may promote innovations (Levine et al. 2017). Additionally, the extant literature suggests that reducing insider trading increases stock liquidity that incentivize managers to invest in long-run, value-maximizing projects (for example, Levine et al. 2017). Thus, it is expected that DLOs would engage in activities that mitigate insiders' ability to exploit other investors. Our hypothesis appears below.

Hypothesis 2 A. DLOs will engage in measures that reduce the control of insider owners.

Proxy Fight is an effective mechanism to reduce insiders' control (Shleifer and Vishny (1986), Bhattacharya (1997), Maug (1999), Bebchuk and Hart (2001), and Gilson and Schwartz (2001)). Because of their position as a debtor, DLOs would have an advantage in gaining corporate control via proxy contests through restrictive covenants or expedited repayment requirement. For example, creditors may agree to provide lower cost capital for business strategy under the agreement of "Proxy Put" as a protection from expropriation of their wealth. In this context, the proxy put provides an incentive to shareholders to vote for the nominees put up by the DLOs. Thus, we hypothesize:

Hypothesis 2 B. DLOs will engage in proxy contests towards seizing control of the dual-affiliated firm.

Grossman and Hart (1988) and Harris and Raviv (1988), among others, contend that anti-takeover provisions (ATPs) serve to entrench firm management and lessen the effectiveness of equity market discipline on management. It is expected that DLOs would engage in activities to thwart ATPs.

Hypothesis 2 C. DLOs will engage in minimizing anti-takeover provisions.

II.3. Improved Efficiency

According to Brav et al. (2016) firms targeted by hedge fund activists experience an improvement in innovation efficiency in terms of increased innovation output, measured by both patent counts and citations. with stronger effects seen among firms with more diversified innovation portfolios. The authors add that the reallocation of innovative resources and the redeployment of human capital contribute to the refocusing of the scope of innovation. Consistent with their goal of reducing internal capital and investment distortions, DLOs are expected to bring about improved efficiencies in investment and innovation decisions in the post-dual period.

Hypothesis 3. DLO-affiliated firms would exhibit higher investment and innovation efficiencies in the post-dual period.

II.4. Focused Acquisitions

Foreign cash holdings create similar agency problems as free cash flows do, with the main difference being that, in the first scenario, free cash flows accumulate abroad. HWZ (2017) report that investors discount value of foreign cash holdings in anticipation of the misuse of cash by the management.

Jensen (1986) recommends three main ways to reduce agency costs of free cash flows: paying dividends, increasing debt, and getting involved in acquisitions. Jensen goes on to suggest that increasing debt is a better tool than increasing dividends (since debt entails commitments, while dividends do not) and focused mergers are superior to conglomerate merger (as synergy adds value). Increasing dividend is not a viable option for the DLO-held firms since the parent firm suffers from illiquidity, a problem that is rooted in their inability to access its cash holdings abroad.

Issuance of debt is an effective tool for controlling free cash-flow related agency costs but falls short when controlling agency costs that are related to foreign cash holdings. These limitations leave only one option open to DLOs which is to use foreign cash holdings to acquire foreign firms, focusing primarily on mergers that create synergy. In the same vein, HWZ (2017) suggest that, in a trade-off between cash repatriation and foreign investments, the managers would opt to keep money abroad if they think the money could be used to make foreign acquisitions with valuable synergies. Thus, we hypothesize:

Hypothesis 4. DLOs would engage in foreign acquisitions, especially those that create synergy.

III. Data

III.1. Sample

We define U.S. MNCs as corporations incorporated in the U.S. that report foreign sales, foreign income or foreign taxes in any year in our sample. We exclude firms in finance and utility industries. Our treatment sample consists of 658 firms in which hedge funds hold dual positions (DLO firms) during the 2007-2014 period. This period is characterized by US firms holding increased leverage along with a surge of institutional investor activism.

Appendix A describes issued new bonds and equity held by DLOs by year. Appendix A also reports average equity held by DLOs as a percentage of total equity. On average DLOs hold $14.958 billion in newly issued bonds and 6.13 percent of total equity.

III.1.1. Sub-sample

To facilitate hypothesis testing, we form a control group consisting of MNCs in which LRFs owns shares but do not simultaneously hold bonds. The control firms are matched with

treated firms in terms of the industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in tax haven countries. The combined sample (treatment and control) comprises 9070 firm-year observations.

Table 1. ***Firm Characteristics: DLOs vs. Controls***
This table reports summary statics for US MNCs with DLOs along with matched control firms. The sample consists of 658 unique U.S. MNCs in which DLOs hold dual positions during the 2007-2014 period. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. The combined sample comprises 9070 firm (both DLO and control)-year observations. We compute foreign and domestic assets and profit margins using the Compustat geographic segment file. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)
	DLOs	Control	DLOs-Control
Size	8.406	5.952	2.455***
Domestic Assets/Total Assets	0.804	0.910	-0.106***
Foreign Assets/Total Assets	0.196	0.090	0.106***
Cash (in $mil)	1630.107	712.470	917.637***
Cash/Total Assets	0.338	0.976	-0.638***
Leverage	0.318	0.237	0.081***
Domestic Profit Margin	0.010	0.014	-0.004**
Foreign Profit Margin	0.033	0.020	0.013***
Dividend-paying firms /total # of firms	0.718	0.461	0.257***

Table 1 provides summary statistics of the DLO firms as well as the control group. The treatment group is significantly larger in size than the control group. As a percentage of total assets, the treatment group invests significantly more in foreign assets and significantly less in domestic assets than their control counterpart, providing preliminary evidence of more severe internal capital distortions of the treatment group. A significantly larger number of DLO firms are dividend payers and carry more debt. Finally, the control group carries more cash (as a percentage of total assets) than the treatment group.

III. 2. Variables

III.2.1. Dual ownership

We identify dual ownership by adopting "brand matching" approach developed by Bodnaruk & Rossi (2016) and measure dual ownership at the financial conglomerate level. The financial conglomerate holding is aggregated holdings from the subsidiary to the parent level. We follow our matching procedure with manual check for accuracy. Finally, we exclude firms, which have dual ownership by highly regulated institutional investors such as mutual funds, pension funds and insurance companies from our main sample. We determine bond ownership by using several SEC filings such as:

a) Schedule 13D which makes it mandatory to file for anyone acquires beneficial ownership of more than 5% of any security class of publicly traded;

b) Schedule 13F and Proxy Statements for owners with beneficial ownership of less than 5% in bonds.

III.2.2. Governance variables

Insider Trading: Insiders' stock purchases (sales), denoted as ISP (ISS), are measured as the amount of stock purchased (sold) by insiders scaled by total assets at time t. Insider ownership (IS) is measured as percentage of shares held by insiders relative to total shares outstanding. The Insider trading data are collected from the Bloomberg.

Covenants violations: This is an indicator variable (CV) that takes on a value of 1 if information about a firm's covenant violation is available in the dataset of Roberts and Sufi (2009). The dataset contains all covenants violation filed with the SEC during 1996 to 2012.

Proxy contest: Information about victory of a dissident in a proxy contest (*Vict*) is measured as the sum of its full victory (*Vict Full*), partial victory (*Vict Part*) and settlement

(*Settle*). The information about results of proxy contests is retrieved from the SDC Platinum.

Anti-takeover provisions: The proxy variables representing anti-takeover provisions take on a value of one if a firm has the following anti-takeover provision: Classified board (CBoard), Bylaw, poison pills and golden parachute. Bylaw is charter or amendments designed to guard against a hostile takeover. The Bylaw restricts shareholders' ability to change the board of directors or reject an undesirable takeover bid. The relevant data have been obtained from Institutional Shareholder Services.

III.2.3. Innovation measures

Innovation quantity: To construct the innovation variables, we use patent applications filed with the USPTO [3]. We measure innovation output by the total number of patent counts. Following Bena and Li (2014), we compute the patent count as follows. First, we calculate the total number of awarded patents to firm i in each technology class k and each application year t and scaled it by the average number of awarded patents in corresponding technology class k and application year t across all firms that were granted at least one patent. Second, for each firm in each year we calculate total scaled number of awarded patents across all technology class k in year t: it is the total number of awarded patents to firm i in year t in technology class k scaled by the median[4] number of granted applications in this firm's technology class k in year t.

[3] The existing innovation literature discusses truncation problems associated with the NBER database. The truncation problem occurs because many patent applications filed during 2005 and 2006 had not been granted by 2006. We used the patent database retrieved in May 2017, which provides us with about two-years safety lag. Therefore, our study is less subject to the truncation problem pointed out by Hall et al. (2001).

[4] The results are robust when innovation measures are scaled by average number of granted applications in corresponding to firm's i technology class k and application year t.

Innovation quantity. Following the innovation literature, we measure a firm's innovation in the year of application. Griliches et al. (1986) argue that the application year better captures the actual time of innovation than the grant year. We set the number of patents to zero for companies that have no patent information available from the patent database.[5] To measure the quality of innovation: we use two proxies: Citation and Patent Scope.

Innovation quality 1: Citation

The citation is calculated as the total quantity of forward citations received during the latest five years since granting of a patent. According to the innovation literature, the number of forward citations measures the technological importance of the patent for the development of subsequent technologies and reflects the economic value of inventions. In contrast, the backward citations are citations that assess the degree of novelty of invention and investigate the knowledge transfers in terms of citations networks.

Innovation quality 2: Scope

We measure technological and economic value of patent by patent scope. The patent scope was first discussed by Lerner (1994) who argues that technological scope of a firm portfolio significantly affects the valuation of the firm. Following Lerner (1994), we construct patent scope as the number of unique four digits classes of International Patent Classification (IPC) in a given patent documentation relative

[5] The full description of variables is provided in Appendix B.

to the maximum scope in the same IPC class and application year. The higher the patent scope, the higher is the market value of a patent.

Innovation efficiency: We measure innovative efficiency in terms of patent efficiency (IE_pat) and citation efficiency (IE_cite) by following Hirshleifer et al (2013). We also measure scope efficiency (IE_scope) in a similar manner. For example, IE_pat is constructed as patents count scaled by cumulative R&D over past five years with 20% depreciation rate:

$$\mathrm{IE}_{\mathrm{pat}_{i,t}} = \frac{Patents_{i,t}}{(R\&D_{i,t-2} + 0.8 * R\&D_{i,t-3} + 0.6 * R\&D_{i,t-4} + 0.4 * R\&D_{i,t-5} + 0.2 * R\&D_{i,t-6})}$$

The efficiency of innovation quality is the sum of citation received during last five years scaled by cumulative R&D expenditure over past five years as follows:

$$\mathrm{IE\_cite}_{i,t} = \frac{\sum_{t}^{t-5} Citations}{(R\&D_{i,t-3} + R\&D_{i,t-4} + R\&D_{i,t-5} + R\&D_{i,t-6} + R\&D_{i,t-7})}$$

The efficiency of patent scope is computed in the same way as IE_cite:

$$\mathrm{IE\_scope}_{i,t} = \frac{\#Patent\ Scope_{i,t}}{(R\&D_{i,t-3} + R\&D_{i,t-4} + R\&D_{i,t-5} + R\&D_{i,t-6} + R\&D_{i,t-7})}$$

IV. Results

In this section, we test the hypothesis that DLO-firms have greater internal capital and investment distortions than non-target firms. HWZ (2017) conclude that the repatriation costs of foreign cash cause a significant discount that investors place on a firm's foreign cash holdings, leading to disruptions in the internal capital market and resulting investment distortion (i.e., domestic underinvestment and overseas overinvestment): the higher the repatriation tax,

borrowing costs and agency problems, the higher are the investment distortions. We measure the severity of the repatriation tax problems by the following measures: foreign pre-tax income as a percentage of the total income, ratio of the number of tax-heaven subsidiaries to the total number of foreign subsidiaries, 3-year average of free cash flows divided by 3-year average total assets (Free CF/TA), dividend payout ratios (Div/E), and leverage (total debt divided by total assets).In this section, we also compare the dual firms and non-dual funds in terms of a) corporate governance issues, b) innovation efficiency, as well as c) performance during the pre-dual period.

IV.1. Testing Hypothesis 1: Identification of Targets (Pre-dual Period)

IV.1.1. Repatriation tax cost

Table 2, Panel A compares the DLO-group and the control group based on the extent of their exposure to repatriation costs.

Table 2. Panel A: Exposure to repatriation costs

Pre-tax Income foreign (FPI) and total income (TI) comes from COMPUSTAT. # of foreign subsidiaries (TFS) and # tax haven subsidiaries (THS) comes from 10-k, where if no information is reported we set # of subsidiaries in tax haven countries to zero. Free cash flow, dividend, total debt and assets derived from COMPUSTAT. The ratio of dividends (Div) to the total assets (TA) denoted as Div/TA. The ratio of dividends (Div) to earnings (E) is denoted as a Div/E. This table contains of 3686 firm-year observations of the three years, pre-event window. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. All variables are defined at Appendix B. To dilute the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	DLOs	Control	Diff (DLOs-Control)
	(1)	(2)	(3)
FPI/TI	0.240	0.128	0.112***
THS/TFS	0.163	0.108	0.055***
FCF/TA	0.015	-0.017	0.032***
Debt Ratio	0.319	0.242	0.077***
Div/E	0.211	0.179	0.032

Table 2. Panel B: Shareholdings by Less Regulated Funds (LRFs) - DLOs vs. Control
This table summarize institutional ownership in pre-dual ownership period. The institutional ownership computed from 13-F filings. The shares held by less regulated funds (LRF) as the percent of total shares outstanding (TSO) is denoted as LRF/TSO. The sharers held by LRF as percent of shares held by all institutional owners denoted as LRF/TIO. The percentage of shares outstanding held by DLOs denoted as DLO_SH. The percentage of DLO_SH in LRF is denoted as DLO_SH /LRF. The DLO_SH at time t relative to the legged DLO_SH is measured as a ratio. This table contains of 3686 firm-year observations of the three years, pre-event window. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. All variables are defined at Appendix B. To dilute the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	DLOs	Control	Diff (DLOs-Control)
	(1)	(2)	(3)
LRF_{t-1}/TSO_{t-1}	38.122	35.581	2.541
LRF_{t-2}/TSO_{t-2}	38.376	33.586	4.791***
LRF_{t-3}/TSO_{t-3}	39.158	32.452	6.706***
$[LRF_t/TSO_t] - [LRF_{t-1}/TSO_{t-1}]$	17.670	-8.285	25.955***
$[LRF_t/TSO_t] - [LRF_{t-2}/TSO_{t-2}]$	19.704	-3.718	23.422***
$[LRF_t/TSO_t] - [LRF_{t-3}/TSO_{t-3}]$	21.059	0.687	20.372***
$[LRF_t/IO_t] - [LRF_{t-1}/IO_{t-1}]$	17.105	-11.415	28.520***
$[LRF_t/IO_t] - [LRF_{t-1}/IO_{t-2}]$	19.868	-4.490	24.358***
$[LRF_t/IO_t] - [LRF_{t-1}/IO_{t-3}]$	21.127	1.780	19.347***
DLO_SH_t/DLO_SH_{t-1}	12.879	0	-
DLO_SH_t/DLO_SH_{t-2}	43.146	0	-
DLO_SH_t/DLO_SH_{t-3}	64.037	0	-
$[DLO\_SH_t/LRF_t] - [DLO\_SH_{t-1}/LRF_{t-1}]$	5.593	0	-
$[DLO\_SH_t/LRF_t] - [DLO\_SH_{t-1}/LRF_{t-2}]$	6.147	0	-
$[DLO\_SH_t/LRF_t] - [DLO\_SH_{t-1}/LRF_{t-3}]$	6.781	0	-

It shows that DLO firms have a significantly larger proportion of foreign pre-tax income in total income and significantly higher ratio of subsidiaries in the tax haven countries relative to all foreign subsidiaries than control firms, with both variables being significant at the 1% level. This confirms our expectation that the target firms might face more inflexibility of internal capital markets due to the immobility or trap of foreign income overseas. Panel A also shows that targets firms have on average significantly higher free cash flow (Free CF/TA) than the control group,

due to a higher portion of cash flows being trapped abroad. These findings suggest that DLOs choose their targets based on the severity of their exposure to repatriation taxes.

Panel B of Table 2 shows that hedge funds begin to increase their shareholdings starting at least three years before they take dual ownerships in the targets, while decreasing their holdings in the control firms. This evidence might imply that dual ownerships involve a long-term planning.

IV.1.2. Managerial control

The management has the incentive to maintain control of the firm it manages. Three major ways the management would like to retain its control are via a) performing insider trading, b) maintaining anti-takeover provisions (ATPs), and c) combatting proxy fights. In this subsection, we compare Dual firms with control firms in terms of managerial efforts to entrench themselves.

Table 3. Panel A: Insider Trading and Covenants Violation – Pre-Dual Period
This table contains of 1770 (3686) firm-years observations of insider trading (covenant violations) during the three years, pre-event window. All variables are defined at Appendix B. The insider trading data comes from Bloomberg and is from 2010. Insider Ownership (IS) measured as stock held by insiders relative to total shares outstanding, in per cent ages. Insiders stock purchases (sales) denoted as ISP (ISS) measured as the amount of stock purchased (sold) by insiders scaled by total assets at time t. CV is an indicator variable, which takes value of 1 if information about a firm covenant violation is available in the dataset of Roberts and Sufi, (2009). The dataset contains all covenants violation filed with SEC during 1996 to 2012. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. To dilute the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	DLOs	Control	Diff (DLOs-Control)
	(1)	(2)	(3)
IS	2.69	10.15	-7.46***
ISP	7.15	10.11	-2.96
ISS	0.01	0.02	-0.01**
CV	0.01	0.02	-0.01***

Table 3, Panel A compares 3-year average of insider trading and covenants violations between the target group and the control group during the pre-dual period. Panel A demonstrates

that insider ownership as well as insider activities are actually *lower* for the target group than the control group. This phenomenon might be explained in the following manner: as the DLOs acquire more shares of the target group (than the control group) preceding the acquisition of dual ownerships (Table 2, Panel B), their activism (i.e., reducing the insider trading) might have begun years before they take on dual ownership.

Table 3. Panel B: Proxy Fight --Pre-event period.
This table compares the means of proxy fights between the DLO group and the control group during the pre-event window. Appendix B describes all variables. The victory of a dissident in proxy contest (Vict) is measured as sum of its full victory (Vict Full), partial victory (Vict Part) and settlement (Settle). The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. We use proportion two-tailed z-test to examine the significance of difference in proportion between groups. Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	DLOs	Control	Diff (DLOs-Control)
	(1)	(2)	(3)
Vict	0.025	0.031	-0.005
Vict Part	0.020	0.023	-0.003
Vict Full	0.020	0.023	-0.003
Settle	0.024	0.028	-0.004

Table 3, Panel B compares the success rates in proxy contests between DLO firms and the control group. The success occurs when the three-year average number of victories in proxy fight after dual ownership exceeds the average number of victories in the three years prior to dual ownership. Panel A shows that DLO firms do not experience greater success than the control firms. Perhaps the same explanation as offered in the context of insider trading applies here.

Panel C of Table 3 indicates that DLO firms have more stringent anti-takeover provisions than the control firms during the pre-dual period. The former group exhibits higher classified board (0.208), Bylaw amendments (0.384), poison pills (0.108) and golden parachutes (0.287) compared to 0.137, 0.214, 0.075, and 0.170 respectively for the control group. The presence of a higher number of different classes of ATPs might be another reason why DLOs select these firms. To

sum up the findings of Table 3, managers of DLO firms are more entrenched than their non-DLO counterparts.

Table 3. Panel C: Antitakeover provision (Pre-Event Period). This table compares the means of antitakeover provisions between the DLO group and the control group during the of pre-event window. Antitakeover provisions are Staggered Board (CBoard), bylaw provision (Bylaw), Poison Pills and Golden Parachute. Appendix B describes all variables. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in tax haven countries. We use proportion two-tailed z-test to examine the significance of difference in proportion between groups. Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	DLOs	Control	Diff (DLOs-Control)
	(1)	(2)	(3)
CBoard	0.208	0.137	0.070***
Bylaw	0.384	0.214	0.171***
Poison Pills	0.108	0.075	0.034***
Golden Parachute	0.287	0.170	0.117***

Table 4 employs a logit model to identify the features that differentiate the DLO group from the control group. The dependent variable is a dummy that takes on a value of 1 for a target firm, and 0 for a control firm. Overall, Table 4 shows that DLOs are more likely to target MNCs that have higher anti-takeover provision, higher free cashflow, with higher proportion of foreign pre-tax income, and higher proportion of subsidiaries in the tax haven countries. In other words, potential agency problems are greater for the DLO group than the non-DLO one.

Table 4. Which MNCs are more likely to have DLOs?

This table reports coefficient estimates from logit models. The dependent variable is equal to one for the MNCs with DLOs, and zero for the MNCs without DLOs. Both DLOs and control are MNCs. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. Specifications include either no fixed effects (columns: 1,3,5 and 7) or industry and year fixed effects (columns: 2,4,6 and 8). All variables are defined in Appendix B. Antitakeover defenses are measured by staggered board (CBoard), Bylaw profession, poison pills and golden parachutes. FPI/TI is a ratio of foreign pre-tax income (FPI) to the total income (TI). The variable THS/TS is the ratio of number of foreign subsidiaries in the tax haven countries (THS) to the total number of subsidiaries (TS). All continuous variables are winsorized at 1% level. Z-statistics are reported in parenthesis. Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CBoard	0.340***	0.354***						
	(5.995)	(6.013)						
Bylaw			0.916***	0.961***				
			(18.688)	(18.852)				
Poison Pills					0.303***	0.313***		
					(3.959)	(3.944)		
Golden Parachutes							0.683***	0.751***
							(13.451)	(14.067)
FCF/TA	0.712***	0.956***	0.185	0.425**	0.793***	1.028***	0.459**	0.691***
	(3.923)	(4.780)	(1.007)	(2.099)	(4.387)	(5.153)	(2.515)	(3.440)
FPI/TI	0.314***	0.337***	0.271***	0.299***	0.315***	0.336***	0.292***	0.317***
	(7.437)	(7.689)	(6.374)	(6.754)	(7.470)	(7.660)	(6.907)	(7.203)
THS/TS	1.374***	1.481***	1.124***	1.237***	1.385***	1.490***	1.259***	1.372***
	(11.633)	(12.106)	(9.487)	(10.065)	(11.736)	(12.204)	(10.648)	(11.199)
R&D	-2.624***	-1.310***	-2.597***	-1.292***	-2.641***	-1.243***	-2.599***	-1.260***
	(-7.531)	(-2.861)	(-7.367)	(-2.791)	(-7.577)	(-2.716)	(-7.422)	(-2.740)
N	8306	8292	8306	8292	8306	8292	8306	8292
pseudo R-sq	0.036	0.052	0.064	0.081	0.035	0.050	0.049	0.066
Year Dummy	No	Yes	No	Yes	No	Yes	No	Yes
Industry Dummy	No	Yes	No	Yes	No	Yes	No	Yes

IV.1. 3. Innovation

Table 5 provides evidence that indicates that the targets were more efficient in terms of innovations even before hedge funds took dual positions in these firms.

Table 5. Innovation Efficiency in the Pre-Dual Period

This table reports analysis of difference in means (t-test) of innovation performance and capital expenditures of DLO firms and control firms over the three-year pre-event window. (Definitions of all variables are provided in Appendix B.) Patent counts (Pat) and Patent's forward citations are retrieved from the USPTO. Dollar measure of patents (Pat($)) obtained from Kogan et al. (2017). The number of patents and number of citations normalized by median # of patents (citations) in the corresponding technological class. R&D, CAPEX and assets derived from COMPUSTAT. The measures of innovation efficiency constructed following Hirshleifer et al (2013) and are log transformation one plus innovative efficiency aggregated at the US MNCs (aggregated foreign level) such as: patent counts denoted as IE Pat (IE FPat); efficiency of the recent five years forward citations denoted as IE Cite (IE FCite); and efficiency of patent scope denoted as IE scope (IE FScope). The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. To dilute the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	DLOs	Control	Diff (DLOs-Control)
	(1)	(2)	(3)
Pat($)/TA	0.0007	0.0004	.0003***
Pat/TA	0.0007	0.0012	-.0005***
FPat/TA	0.0000	0.0000	0.0000
Cit/Pat	0.5428	0.4084	.13435***
FCit/FPat	0.0905	0.0320	.05840***
R&D/FCF	0.056	0.111	-0.055
CAPX/FCF	0.075	0.604	-0.529*
Pat/R&D	0.0156	0.0161	-0.0006
FPat/R&D	0.0002	0.0169	-0.0168
IE Pat	3.0933	2.6747	0.4187
IE Cite	8.5335	5.8206	2.7129***
IE Scope	4.0813	3.5285	0.5528
IE FPat	0.0157	0.0080	.0077***
IE FCite	0.0282	0.0100	.01824***
IE FScope	0.0148	0.0059	.0089***

A possible explanation might lie in DLOs being attracted by superior performance of the targets to begin with as suggested by Brav et al. (2008) that hedge funds target over performing

firms. Table 2 shows that while hedge funds increase their equity ownership in DLO firms in the pre-dual period, they decrease their equity holding in the control group actually diminishes during the same period. On a net basis, DLOs' equity ownership as a percentage of total number of shares significantly increases (at the 1% significance level) from t-1, t-2, and t-3 to t by 25.95%, 23.42%, and 20.37% respectively. Also, during the same period, the DLO equity ownership as a proportion to total institutional ownerships increases by 28.52%, 24.36%, 19.34% respectively.

IV.1. 4. Performance

Table 6 compares the accounting (ROA, ROE, and EBITDA/SALES) as well as market performance (P/B) between the target group and the control group during the pre-dual period. The table shows that accounting performance of the target group is superior to that of the control group. The results imply that in spite of a greater exposure to repatriation tax costs, target firms exhibit a better performance record in the pre-dual period.

Table 6. Performance in the Pre-Dual Period: DLOs vs. Control
This table compares the operating performances of DLO firms and their peers over the three-year pre-event window. All variables are defined at Appendix B. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. To dilute the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	DLOs	Control	Diff (DLOs-Control)
	(1)	(2)	(3)
ROA	0.013	-0.020	0.032***
ROE	0.070	0.012	0.058**
M/B	2.268	2.118	0.150
EBITDA/SALES	0.107	-0.070	0.176***

The market performance (M/B) of dual target firms, however, is not significantly different from that of the control firms. It is possible that the market's positive reaction to the superior innovation occurs with a lag. In explaining such lag, Hirshleifer et al. (2013) state

"…. investors will underreact to the information content in innovative efficiency because of the difficulty evaluating the economic implications of patents and patent citations. If so, then firms that are more efficient in innovations will be undervalued relative to firms that are less efficient in innovations." (page 2)

IV.1.5. Summarizing test results: Hypothesis 1

- Before taking dual position, hedge funds seem to solidify their equity holdings in the MNCs they target;
- In terms of innovation activities and overall performance, dual firms are at least as efficient as non-dual firms: increasing equity ownership by hedge funds in dual firms might explain this phenomenon;
- The main factors that differentiate dual firms from non-duals in the pre-dual period are that the former group 1) has greater exposure to repatriation tax costs, and 2) exhibit greater managerial entrenchment problems than the latter group.

IV.2. Testing Hypothesis 2: Strategies to Reduce Managerial Control

IV. 2.1. Reducing inside trading

Table 7, Panel A compares changes in insider trading and covenants violations between the target and control from the pre-dual period to the post-dual period. The average insider ownership decreased for both groups following the dual ownership year, but the decrease is significantly higher for the control firms (by 0.036 points). The average insider purchases and sales for the DLO firms, however, decrease more than those of the control group (i.e., the former group experiences a higher decrease in insider purchases (-6.557) and insider sales (-0.023) than the latter. In terms of covenant violations too, the former group faces a greater decrease in covenant violation than the control group.

Table 7. Panel A: Insider Trading and Covenants Violation --Pre-Post Periods
This Table compares changes in insider trading activities between the DLO group and the control group from before to after the dual ownerships. The source of the insider trading data is Bloomberg, available starting 2010. The sample includes firms with DLOs firms and their control firms. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Δ denotes average three-year change between post- and pre-periods in insider purchase (ΔInsPurch), insider sales (ΔInsSale) and insider share outstanding (ΔInsShare). The control firms are firms matched with DLOs firms in the same industry and year using propensity scores (nearest neighbor) without replacement on total assets, number of foreign subsidiaries and number of subsidiaries in the tax haven countries. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	DLOs	Control	Diff (DLOs-Control)
ΔIS	-0.040	-0.076	.036***
ΔISP	-6.557	-4.157	-2.340***
ΔISS	-0.023	-0.013	-.009***
ΔCV	-0.005	-0.001	-.004**

Overall findings support our prediction that insider trading activities as well as covenant violations would decrease more for the DLO firms than for control firms.

IV. 2.2. Success rate of proxy fights

Table 7, Panel B compares the success history of proxy contests between the target group and the control group both in pre-dual and post-dual periods. Table 3, Panel B shows that there is no significant difference between the two groups in terms of the final outcome of proxy fights (i.e., partial victory, full victory, and settlements successes) in the pre-dual period. Panel B of Table 7, however, shows that proportion of activists' victories in target firms are higher (0.68) than the control firms (0.32). Moreover, DLO firms achieve greater proportion of full, partial, settlement in target firms (0.69, 0.69 and 0.51) than control firms. The test of independence of the contests success is significant at the 1% significance level for total successes, full successes and partial successes.

Thus, successes in proxy contests is contingent on hedge funds taking on dual positions. The independence test does not find significant difference in settlement successes between the two groups. Overall, Panel B suggests that affiliation with DLOs has brought greater proxy-contest success for the stockholders of DLO firms.

Table 7. Panel B: Independence Test of Proxy Contests from DLOs.
This Table compares changes in proxy contests between the DLO group and the control group from before to after the dual ownerships. This table reports proportion of positive changes of a dissident victory in proxy contests (column 1 and 2). The change is computed as average difference between proxy contests frequencies during three succeeding and preceding years on average at year t. The column (3) report total frequencies of the positive change. The victory of proxy contest (Vict) is measured as sum of full victory (Vict Full), partial victory (Vict Part) and settlement (Settle). Column (4) reports p-value from Chi square test of independence of the positive change in proxy fights on DLOs. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country.

	DLOs	Control	Total Positive (Δ)	P-value
Positive Change (Δ)	(1)	(2)	(3)	(4)
ΔVict	0.68	0.32	446	0.00
ΔVict Part	0.69	0.31	377	0.00
ΔVict Full	0.69	0.31	399	0.00
ΔSettle	0.51	0.49	277	0.76

IV. 2.3. Fighting anti-takeover provisions

Table 7, Panel C reports changes in proportion of ATPs from 3-year average before to 3-year average after the dual ownership. We define success as when the change is negative (i.e., ATPs decline). Panel B demonstrates that DLO firms have greater success in removing ATPs than their non-dual counterparts, especially in removing Classified Board (0.68), in amending bylaw provision (0.70), removing poison pills (0.69) and removing golden parachutes (0.71). The independence test is significant at the 1% significance level across all measures of ATPs and suggests that the success rate of removing ATPs is contingent on dual ownership.

Table 7. Panel C: Independence Test of Change in ATPs from DLOs.
The table compares change in ATPs (Cboard, ByLaw, Ppills and Gpapprachute) between the DLO group and the control group from before to after the dual ownerships. The change is computed as average difference between ATP frequencies during three succeeding and preceding years on average at year t. Colum (1) and column (2) report proportion of decrease in ATPs, while column (3) total number of cases where negative changes have occurred. Column (4) reports p-value from Chi square test of independence change in ATP on DLOs. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country.

	(1)	(2)	(3)	(4)
Negative Change (Δ)	DLOs	Control	Total Negative (Δ)	P-value
ΔCboard	0.68	0.32	948	0.00
ΔBylaw	0.70	0.30	1,400	0.00
ΔPpills	0.69	0.31	663	0.00
ΔGparachute	0.71	0.29	1,161	0.00

IV. 2.4. Summarizing test results: Hypothesis 2

In the post-dual period, DLO firms have greater success than non-DLO firms in a) reducing insider trading activities as well as covenant violations; b) increasing the success rate of proxy contests; c) removing ATPs.

IV.3. Hypothesis 3: Reducing Internal Capital Problems & Improving Investment Efficiencies

HWZ (2017) report that, stemming from high foreign cash balances, MNCs face internal capital problems that translate into investment distortions---domestic underinvestment and foreign overinvestment. Our premise is that less regulated funds would first target those MNCs that are likely to face greater repatriation costs, then engage in efforts to usurp control from the management of these firms, and finally, act on reducing internal capital problems and improving investment efficiencies. In the next few subsections, we assess the extent of success of the DLOs in improving the efficiencies in these areas.

Table 8. Analysis of Investment Constraints

This panel shows changes in financial delays around new debt issuance. The dependent variables are text based measures of financial constraints developed by Hoberg and Maksimovic, (2014). The higher value of a dependent variable shows that a firm is more similar to a set of firms known to be at risk of liquidity issues (Investment Delay) and presumes solving this delay by: equity issuance (Equity Delay), issuing debt (Debt Delay) and issuing private placement (Private Placement). We control for Leverage (Total Debt/Total Assets), Size (log transformation of one plus Total Assets) and total share outstanding held by institutional investors (IO). The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. DLOs is a dummy variable, which takes value of one if a firm belongs to DLOs group and zero otherwise. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. Post is excluded from the model because it was subsumed by year fixed effects. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (calculated based on robust standard errors). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Investment Delay	Investment Delay	Equity Delay	Equity Delay	Debt Delay	Debt Delay	Private Placement	Private Placement
DLOs	0.013***	0.013***	0.013***	0.008***	0.003*	0.008***	0.007***	0.001
	(5.461)	(5.742)	(5.473)	(4.039)	(1.887)	(4.938)	(3.918)	(0.619)
DLOs*Post	-0.009***	-0.011***	-0.005*	-0.008***	-0.005***	-0.004**	-0.000	-0.005**
	(-3.064)	(-3.842)	(-1.827)	(-3.379)	(-2.578)	(-2.055)	(-0.195)	(-2.290)
Leverage	0.025***		0.013***		0.033***		-0.002	
	(5.715)		(3.148)		(11.062)		(-0.706)	
Size	-0.001**		-0.002***		-0.000		-0.003***	
	(-2.307)		(-4.200)		(-0.294)		(-6.581)	
IO	-0.002		-0.005**		0.010***		-0.003	
	(-0.729)		(-2.143)		(5.533)		(-1.577)	
N	6220	6220	6220	6220	6220	6220	6220	6220
adj. R-sq	0.051	0.045	0.055	0.048	0.077	0.057	0.088	0.080

IV.3.1. Reducing internal capital problems

An indirect result of distortions in the internal capital market is illiquidity stemming from increasing costs of external financing.[6] Illiquidity causes the firm to postpone investments (I*nvestment Delay*), delay equity (*Equity Delay*) and/or debt issues (*Debt Delay*) and constrain it to resort to private placement (*Private Placement)* (Hoberg and Maksimovic, 2014). If DLOs are successful in mitigating the illiquidity problem, we should find DLO firms to lessen delays in investments, equity issuance, and/or debt issuance.

The results presented in Table 8 show that DLO firms more effectively mitigate illiquidity problem than their non-DLO counterparts. It shows a significant decrease (at 1% significance level) in investments delays in the post dual period relative to non-DLO firms. Similarly, DLO firms reduce delay in issuing new equity or debt and the reliance on private placement: the results hold after controlling for a firm's leverage, size and shares held by institutional investors across all measures of financial constraints except the private placement.

IV.3. 2. Increasing investment efficiency---domestic and foreign

In this subsection, we answer the following question: Were DLOs able to reduce investment distortions (domestic underinvestment and foreign overinvestment) in the post-dual period? In so doing, we modify the HWZ (2017) model to compare DLO firms with control firms in terms of their domestic, foreign, and R&D investments. To check for robustness, we also use the HWZ (2017) model to estimate potential domestic underinvestment using domestic and foreign

[6] Froot, Scharfstein, Stein (1993) concluded that cost and difficulties of raising external finance my force firms to underinvest.

sales, profit margin and assets in one of the models. The results are presented in Table 9 (Panel A and Panel B).

Table 9. Underinvestment After Dual Ownership

Panel A of this table presents modeling of domestic underinvestment following Harford, Wang and Zhang (2017). We modeled underinvestment by retaining residuals from regressing domestic investments of US MNCs' (domestic capital expenses scaled by domestic assets) on US MNC segments' characteristics such as: domestic sales growth over current period (Domestic Sale Growth), foreign sales growth over current period (Foreign Sale Growth), net domestic income over domestic sales (Domestic Profit Margin), net foreign income over foreign sales (Foreign Profit Margin) and log of one plus domestic as well foreign book assets. Next, we construct Domestic underinvestment as absolute value of negative residuals and zeros otherwise. Panel B. Probit and Difference-in-Difference analysis using regression model of domestic underinvestment. Columns (1) - (4) of this table reports results of probit analysis. While, column (5) reports results from Difference-in-difference analysis. DLOs is a dummy variable, which takes value of one if a firm belongs to a foreign subsidiary of the DLOs group and zero otherwise. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. DLOs*Post is an interaction term between DLOs and Post-dual period. All models include industry and year fixed effects. To dilute the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. T-statistics are reported in parenthesis (calculated based on standard clustered on firm level). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A. Domestic capital expenditures/ Domestic Assets	
Domestic Sale Growth	0.014**
	(2.242)
Foreign Sale Growth	0.017
	(0.388)
Domestic Profit Margin	0.183***
	(4.033)
Foreign Profit Margin	0.094
	(0.993)
Domestic assets	0.001
	(0.498)
Foreign Assets	0.000
	(0.282)
N	1706
adj. R-sq	0.417

Panel A, Table 9 reports modeling of domestic underinvestment following HWZ (2017) while Panel B reports probit analysis (Columns 1- 4) while panel B reports difference-in-difference analysis of domestic underinvestment. The domestic investment is defined as domestic capital expenditures and expenses as a percentage of book value of domestic assets. The coefficients on

Post (Columns 1 - 4) suggest decrease in domestic underinvestment for DLO firms and interaction term between DLOs and Post (Column 5) suggest that in the post-dual period, dual firms reduce total domestic underinvestment (at the 5% significant level) relative to their peers. Overall, results of these section suggest that dual ownership has been more effective in decreasing domestic underinvestment.

Table 9. Panel B: Probit and Difference-in-Difference analysis of domestic underinvestment

Probit and Difference-in-Difference analysis using regression model of domestic underinvestment. Columns (1) - (4) of this table reports results of probit analysis. While, column (5) reports results from Difference-in-difference analysis. DLOs is a dummy variable, which takes value of one if a firm belongs to a foreign subsidiary of the DLOs group and zero otherwise. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. DLOs*Post is an interaction term between DLOs and Post-dual period. All models include industry and year fixed effects. To dilute the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. T-statistics are reported in parenthesis (calculated based on standard clustered on firm level). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. *All specifications include industry and year fixed effects.*

	DLOs	Controls	DLOs	Controls	Difference-in-Difference
	(1)	(3)	(2)	(4)	(5)
	Domestic Underinvestment (=1 if residual < 0)	Domestic Underinvestment (=1 if bottom quartile)	Domestic Underinvestment (=1 if residual < 0)	Domestic Underinvestment (=1 if bottom quartile)	Domestic Underinvestment (absolute value of residual <0)
Post	-0.652**	-0.158	-0.506**	-0.282	
	(-2.254)	(-1.101)	(-2.458)	(-1.644)	
DLOs*Post					-0.008**
					(-2.169)
DLOs					0.005
					(1.366)
Leverage	0.920*	-0.646**	0.128	-0.782**	-0.003
	(1.787)	(-2.270)	(0.363)	(-2.280)	(-0.469)
Size	0.247***	0.024	0.114*	0.020	-0.002**
	(2.659)	(0.613)	(1.817)	(0.458)	(-2.060)
IO	-0.498	-0.391**	-0.333	-0.183	-0.002
	(-1.554)	(-2.237)	(-1.542)	(-0.916)	(-0.422)
N	497	530	363	418	1206
pseudo R-sq	0.099	0.069	0.076	0.133	
adj. R-sq					0.381

Table 10. Panel A: Difference-in-difference Analysis of Innovative Measures

This table consists of two panels: a) aggregate innovation measures at the US MNCs level and b) aggregated foreign innovation measures at the US MNCs level. The sample includes firms with DLOs and their control firms. The dependent variables measured at time t, t1 and t2 and are log transformation one plus patent counts (Pat), sum of five years forward citations (Cite) and patent scope (Scope). The innovation measures are scaled by the median value of the corresponding technological class. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. DLOs is a dummy variable, which takes value of one if a firm belongs to DLOs group and zero otherwise. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. DLOs*Post is an interaction term between DLOs and Post-dual period. Post is excluded from the model because it was subsumed by year fixed effects. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (calculated based on robust standard errors). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Pat	Pat_t1	Pat_t2	Cite	Cite_t1	Cite_t2	Scope	Scope_t1	Scope_t2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DLOs*Post	0.186***	0.292***	0.311***	0.221***	0.193***	0.200***	0.195***	0.172***	0.166***
	(5.008)	(4.809)	(5.147)	(4.954)	(4.128)	(4.008)	(5.175)	(4.297)	(3.797)
DLOs	-0.021	-0.043	-0.044	-0.033	-0.024	-0.018	-0.030	-0.017	-0.003
	(-0.993)	(-1.107)	(-1.132)	(-1.283)	(-0.855)	(-0.563)	(-1.364)	(-0.707)	(-0.099)
R&D	1.461***	3.780***	3.785***	1.842***	2.239***	2.583***	1.507***	1.841***	2.088***
	(9.465)	(12.549)	(12.603)	(8.556)	(9.687)	(10.237)	(9.366)	(10.314)	(10.277)
CAPX	0.003	0.019	-0.001	0.092	-0.080	-0.132	-0.002	-0.173	-0.176
	(0.024)	(0.091)	(-0.004)	(0.651)	(-0.495)	(-0.759)	(-0.015)	(-1.246)	(-1.130)
Size	0.134***	0.261***	0.279***	0.159***	0.184***	0.211***	0.136***	0.160***	0.186***
	(20.443)	(22.966)	(24.291)	(20.125)	(21.266)	(22.781)	(20.392)	(21.333)	(22.578)
Age	0.127***	0.249***	0.277***	0.136***	0.170***	0.208***	0.128***	0.155***	0.192***
	(13.126)	(14.465)	(15.774)	(11.906)	(13.465)	(14.915)	(12.935)	(14.057)	(15.460)
N	6146	6146	6146	6146	6146	6146	6146	6146	6146
adj. R-sq	0.342	0.428	0.454	0.325	0.366	0.401	0.339	0.382	0.412
Year and Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 10. Panel B: Difference-in-difference Analysis of Innovative Measures.

This panel reports the aggregated foreign innovation measures at the US MNCs' parent level. The sample includes firms with DLOs and their control firms. The dependent variables measured at time t, t1 and t2 and are log transformation one plus foreign patent counts (FPat), sum of five years forward citations received by the foreign patents (FCite) and scope of foreign patents (FScope). The innovation measures are scaled by the median value of the corresponding technological class. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. DLOs is a dummy variable, which takes value of one if a firm belongs to DLOs group and zero otherwise. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. DLOs*Post is an interaction term between DLOs and Post dual period. Post is excluded from the model because it was subsumed by year fixed effects. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (calculated based on robust standard errors). Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	FPat	FPat_t1	FPat_t2	FCite	FCite_t1	FCite_t2	FScope	FScope_t1	FScope_t2
Panel B	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DLOs*Post	0.013***	0.001	-0.010	0.010**	-0.001	-0.014	0.012***	-0.001	-0.011
	(3.997)	(0.106)	(-1.141)	(2.262)	(-0.170)	(-1.211)	(3.744)	(-0.145)	(-1.340)
DLOs	-0.001	0.003	0.010*	-0.000	0.007	0.015**	-0.001	0.003	0.012**
	(-0.635)	(1.105)	(1.923)	(-0.169)	(1.497)	(2.251)	(-0.869)	(1.131)	(2.338)
R&D	0.033***	0.071***	0.163***	0.035**	0.092***	0.189***	0.030***	0.063***	0.165***
	(3.213)	(3.543)	(4.556)	(2.354)	(2.914)	(4.019)	(2.828)	(3.338)	(4.433)
CAPX	-0.006	-0.033**	-0.056**	-0.015	-0.040*	-0.067*	-0.005	-0.034**	-0.046*
	(-0.739)	(-1.998)	(-1.996)	(-1.267)	(-1.881)	(-1.952)	(-0.558)	(-2.144)	(-1.667)
Size	0.005***	0.010***	0.019***	0.006***	0.013***	0.023***	0.005***	0.010***	0.019***
	(9.935)	(10.576)	(11.604)	(7.584)	(9.395)	(10.605)	(9.457)	(10.331)	(11.376)
Age	0.006***	0.009***	0.016***	0.007***	0.011***	0.021***	0.006***	0.009***	0.016***
	(8.147)	(7.300)	(7.748)	(6.759)	(6.461)	(7.617)	(7.681)	(7.108)	(7.548)
N	6146	6146	6146	6146	6146	6146	6146	6146	6146
adj. R-sq	0.102	0.156	0.176	0.071	0.120	0.143	0.094	0.150	0.167
Year and Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 11. Difference-in-difference analysis of Innovation Efficiency of Aggregated & Foreign Innovation Measures.

This table presents analysis of innovation efficiency of DLOs firms relative to the control group during the post-dual period. The dependent variables are constructed following Hirshleifer et al (2013) and are log transformation of one plus innovative efficiency aggregated at the parent (foreign segment) level: patent efficiency, IE_pat (IE_fpat); efficiency of the recent five years forward citations, IE_cite (IE_fcite); and efficiency of patent scope, IE_scope (IE_fscope). The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification are based on the Fama and French's (1997) 49 industries. DLOs is a dummy variable, which takes value of one if a firm belongs to DLO group and zero otherwise. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. DLOs*Post is an interaction term between DLOs and Post-dual period. Post is excluded from the model because it was subsumed by year fixed effects. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (calculated based on robust standard errors). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	IE_pat	IE_fpat	IE_cite	IE_fcite	IE_scope	IE_fscope
	(1)	(2)	(3)	(4)	(5)	(6)
DLOs*Post	1.357***	0.009***	1.088	0.009	1.447***	0.007**
	(3.682)	(2.757)	(1.331)	(1.520)	(3.027)	(2.081)
DLOs	0.198	0.003	1.355**	0.005	0.318	0.003
	(0.744)	(1.094)	(2.060)	(1.336)	(0.875)	(1.639)
CAPX	1.619	0.001	6.283*	0.001	3.051	0.005
	(1.163)	(0.088)	(1.663)	(0.037)	(1.548)	(0.568)
Size	-0.130*	0.002***	0.227	0.005***	-0.111	0.002***
	(-1.903)	(3.594)	(1.524)	(6.265)	(-1.254)	(5.313)
Age	0.782***	0.003***	1.031***	0.006***	0.776***	0.003***
	(7.034)	(3.902)	(4.179)	(3.913)	(5.219)	(3.983)
N	6146	6146	6146	6146	6146	6146
adj. R-sq	0.132	0.051	0.149	0.054	0.127	0.056
Year and Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 12: Difference-in-difference Analysis of Innovative Measures at the Foreign Subsidiary Level.

This table reports difference-in-indifference analysis of DLOs activism on innovations of US MNCs' foreign subsidiaries relative to its peers in the same country and industry. The dependent variables measured at time t, t1 and t2 and are log transformation one plus patent counts (Pat), log transformation of one plus total number of citations received (Cite) and patent scope (Scope). Cite and Scope are measured as a percentage of technological median. The innovation measures are scaled by the median value of the corresponding technological class. The control firms are firms matched with foreign subsidiaries of treated firms in the same country, industry and year using propensity scores (nearest neighbor) on size of a foreign subsidiary without replacement. DLOs is a dummy variable, which takes value of one if a firm belongs to a foreign subsidiary of the DLOs group and zero otherwise. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. DLOs*Post is an interaction term between DLOs and Post-dual period. Post is excluded from the model because it was subsumed by year fixed effects. Industry classification based on the Fama and French (1997) 49 industries. To dilute the influence of outliers, all explanatory variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (calculated based on robust standard errors). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. *All specifications include Industry, Year, Country & US MNC Dummies.*

	Pat	Pat_t1	Pat_t2	Cite	Cite_t1	Cite_t2	Scope	Scope_t1	Scope_t2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DLOs*Post	0.003	0.037	0.493***	0.040***	-0.050*	0.090***	0.234	0.018	1.752
	(1.432)	(0.156)	(2.706)	(3.138)	(-1.701)	(2.786)	(1.529)	(0.283)	(0.283)
DLOs	0.000	-1.578***	-1.765***	-0.033***	-0.127***	-0.185***	0.010	-0.028*	-2.763*
	(1.149)	(-3.962)	(-4.187)	(-2.643)	(-9.888)	(-3.241)	(0.262)	(-1.872)	(-1.872)
Cash	0.005*	1.610*	1.153	0.371***	0.110***	0.147***	0.285**	0.024	2.394
	(1.965)	(1.910)	(1.086)	(3.478)	(4.212)	(2.842)	(2.205)	(0.365)	(0.365)
R&D	0.025***	39.742***	43.183***	0.617	1.925**	1.985***	2.842***	2.742***	274.172***
	(2.924)	(3.068)	(3.066)	(0.935)	(2.199)	(5.010)	(3.647)	(2.972)	(2.972)
CAPX	-0.007	-3.356*	-4.543**	-0.163***	-0.197***	0.094	-0.515	-0.225	-22.540
	(-1.070)	(-1.673)	(-2.231)	(-2.972)	(-4.310)	(0.529)	(-0.945)	(-0.792)	(-0.792)
Size	0.000	0.316***	0.336***	0.033*	0.031***	0.073***	0.014	0.019**	1.863**
	(0.709)	(3.320)	(3.681)	(1.924)	(2.676)	(2.757)	(1.087)	(2.075)	(2.075)
Age	-0.001**	-0.058	0.209	-0.056***	0.012	0.152***	-0.022	0.013	1.275
	(-2.321)	(-0.302)	(0.846)	(-5.941)	(1.044)	(2.791)	(-0.927)	(0.715)	(0.715)
N	2267	2267	2267	2267	2267	2267	2267	2267	2267
R-sq	0.066	0.200	0.246	0.057	0.077	0.066	0.077	0.092	0.092

Table 13. Difference-in-difference Analysis of Innovation Efficiency (IE) at the Foreign Subsidiary Level.

This table reports results of difference-in-difference analysis of DLOs activism on innovations of US MNCs' foreign subsidiaries relative to its peers in the same country and industry. The dependent variables constructed following Hirshleifer et al (2013) and are log transformation one plus innovative efficiency aggregated at the publicly traded subsidiary level of US MNCs (foreign subsidiary level) such as: patent counts, IE_fpat; efficiency of the recent five years forward citations, IE_fcite; and efficiency of patent scope IE_fscope. The innovation efficiency variables expressed in percentages. The control firms are firms matched with foreign subsidiaries of treated firms in the same country, industry and year using propensity scores (nearest neighbor) on size of a foreign subsidiary without replacement. DLOs is a dummy variable, which takes value of one if a firm belongs to a foreign subsidiary of the DLOs group and zero otherwise. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. DLOs*Post is an interaction term between DLOs and Post-dual period. Post is excluded from the model because it was subsumed by year fixed effects. Industry classification based on the Fama and French (1997) 49 industries. To dilute the influence of outliers, all explanatory variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (calculated based on robust standard errors). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. *All specifications include Industry, Year, Country & US MNC Dummies.*

	(1)	(2)	(3)
	IE_pat	IE_cite	IE_scope
DLOs*Post	0.031***	0.060***	0.098***
	(2.990)	(3.628)	(3.129)
DLOs	0.064***	-0.001	0.118***
	(3.312)	(-0.091)	(2.793)
Cash	0.543***	0.412**	1.107***
	(4.571)	(2.461)	(5.242)
CAPX	-0.263***	-0.212***	-0.539***
	(-4.237)	(-3.452)	(-3.984)
Size	-0.005	0.008	-0.015**
	(-1.274)	(1.328)	(-2.057)
Age	-0.049***	-0.044***	-0.080***
	(-4.094)	(-3.914)	(-3.572)
N	2286	2286	2286
adj. R-sq	0.023	0.027	0.001

IV.3.3. Increasing Innovation Efficiencies

Do DLOs contribute to targets' innovation efficiency in the post dual period? We answer this question in this section by examining innovation output, quality and innovation efficiency by employing Difference-in-Difference analysis. The results are presented in Tables 10, 11, and 12.

IV. 3.3.1. Innovation output & quality

Table 10, Panel A shows that in the post-dual period, DLO firms significantly increase their innovation output and quality relative to control firms. The results apply to longer time horizon (i.e., t+1 and t+2). For instance, targets significantly increase their innovation output by 0.186 (at the 1% significant level), citations by 0.221 (at the 1% significance level), and scope by 0.195 (at the 1% significance level) during the post-dual era.

Panel B of Table 10 analyzes the same innovation measures in the global context. It shows that aggregate at the parent level foreign measures are qualitatively similar to overall aggregate innovation measures but significant only for the shorter period. For example, three years after dual holdings, the number of foreign patents increased by 0.013 (at the 1% significance level), the number of foreign citations increased by 0.10 (at the 5% significance level) and the foreign scope increased by 0.012 (at the 1% significance level).

IV. 3.3.2. Innovation efficiency

Table 11 shows that targets increase patent innovation efficiency (IE_patent) by 1.357 (at the 1% significance level) as well as scope innovation efficiency (IE_scope) by 1.447 (at the 1% significance level). These results are consistent with corresponding foreign measures. For example, foreign patent innovation efficiency (IE_fpat) increase by 0.009 (at the 1% significance level) and foreign scope efficiency increased (IE_fscope) by 0.007 (at the 5% significance level).

However, aggregated and foreign citation efficiency measures (IE_cite and IE_fcite) are not significant. Taken together, Table 10 and Table 11 show that increases in innovation efficiency in the post-dual period are larger for DLO firms than control firms.

IV. 3.3.3. Innovation----foreign subsidiaries of the DLO firms

Tables 12 and 13 explore if increased innovation efficiencies observed with respect to DLO firms are equally applicable to foreign subsidiaries of these targets. These tables compare innovation measures of foreign subsidiaries of DLO firms with foreign firms in the same industry and in the same country.

Table 12 shows that the number of patents and citations of the subsidiaries of target firms in time t+2 experience a greater increase of 0.493 (at the 1% significance level) and 0.040 (at the 1% significance level) than their foreign counterparts. This result suggest that foreign subsidiaries of the targets increased their innovativeness more than the firms in the countries where the subsidiaries exist.

In Table 13, we compare subsidiaries' innovation efficiency to that of the comparable foreign firms. The subsidiaries enjoy greater increase in their innovation efficiencies than their foreign peers in the post-dual period. For example, innovative efficiency of patents increased by 0.031 (at the 1% significant level), efficiency of citations by 0.060 (at the 1% significance level) and efficiency of scope by 0.098 (at the 1% significance level).

IV. 3.4. Summarizing test results: Hypothesis 3

Overall, the results support our hypothesis that, in the post-dual period, DLO firms have been able to reduce internal capital market deficiencies and improve investment efficiencies not only relative to the pre-dual period but to non-DLO firms as well. More specifically,

- DLO firms, more than non-DLO firms, are able to reduce the inefficiencies induced by internal capital market;
- Dual ownership is more effective in decreasing domestic underinvestment;
- Increases in innovation efficiency in the post-dual period are larger for DLO firms than control firms.

IV. 4. Testing Hypothesis 4: Focused Acquisitions

In practical sense, agency costs of free cash flows are similar to those of foreign cash balance. Therefore, we examine the extent to which Jensen's (1986) prescriptions for mitigating such costs are applicable to foreign cash balances. Jensen (1986) recommends three principal ways to reduce agency costs of free cash flows: increasing dividends, increasing debt, and getting involved in acquisitions. Jensen further suggests that increasing debt is a better way than increasing dividends (since debt requires future commitment, but dividends do not), and a focused merger is superior to conglomerate merger (since the former adds value to the combined firm).

Increasing dividend is not a viable option for the DLO firms or control firms. since the parent firm cannot access the foreign cash holdings. Similarly, issuance of debt has no effect on reducing the cash buildup abroad. Therefore, DLOs are likely to lead their affiliated firms to use the cash abroad to aggressively acquire foreign firms. Bena and Li (2014) suggests that firms with low R&D but lager patent portfolio (more efficient in terms of innovations) would more likely to be an acquirer than target. Since evidence produced above point to DLOs acting long term, an argument can be made in support of them being involved in focused acquisitions. The focused acquisition strategy is reinforced by HWZ (2017):

> " … if managers think that the firm will be able to repatriate foreign cash later at a much reduced or zero cost (due to tax reform or holiday), or the managers think

(correctly or not) that foreign cash can be used to make foreign acquisitions that would have valuable synergies, then managers would view the trade-off differently" (p.1513).

We make the following predictions about merger activities of DLO firms versus non-DLO firms:

- Both DLOs and non-DLOs would use foreign cash holdings to acquire foreign firms;
- The coordination hypothesis proposed by Bodnaruk and Rossi (2016) suggest that DLOs have stronger incentive for facilitating deal completions; Therefore, we expect DLOs to complete greater number of deals than their non-DLO counterparts.
- DLOs would be involved in a greater frequency of focus acquisitions than non-DLOs.
- The premiums paid by DLOs for foreign targets are likely to be higher than those paid by non-DLOs as the former is involved in higher quality (i.e., greater synergy) acquisitions. would be on average higher for firms with improved quality of deals, wherein the quality is pertinent to strategic focus (synergy).

Table 14 presents results of difference-in-difference analysis of acquisition deal completion. During the sample period, DLOs have 4,583 deals and the control group has 1,991 deals. Total number of deals include completed, withdrawn and terminated acquisition deals. DLOs engage in significantly higher number of acquisitions than their counterparts.

The completion ratio is the number of completed acquisitions as a percentage of total number of acquisitions. The results show that DLOs complete a larger number of foreign acquisitions at the 1% significance level), domestic acquisitions (significant at the 5% level) and focused acquisitions (at the significance level of 1%).

Table 14. Difference-in-difference analysis of Acquisition Completion and Premium.
The columns (1) – (4) present analysis of completion ratios, where the dependent variables measured as a percentage of total number of acquisition deals and are Completion Foreign Acquisitions (FA), Completion Domestic Acquisitions (DA), Completion Focused Foreign Acquisitions (FA), and Completion Focused Domestic Acquisitions (DA). In addition, columns (5) though (7) present analyses of acquisition premium, where the dependent variables are premium with respect to the DLOs' average stock price 7 days prior to the acquisition announcement denoted as Premium 7d Px along with disaggregating premium into completion and origin as follows: Premium 7d Px Completed Domestic Acquisitions (DA), Premium 7d Px Completed Foreign Acquisitions (FA), Premium 7d Px Focused Acquisitions (Acq). The measures division into a focused is based on equivalence of a DLOs' and an acquirer's three-digits SIC code. The control firms are firms matched with treated firms in the same industry and year using propensity scores (nearest neighbor) on size, distinct number of foreign subsidiaries and distinct number of subsidiaries in the tax haven country. Industry classification based on the Fama and French (1997) 49 industries. DLOs is a dummy variable, which takes value of one if a firm belongs to DLOs group and zero otherwise. DLOs*Post is an interaction term between DLOs and Post. Post is a dummy variable, which indicates the three-year window [+1, +3] after DLOs activism. Post is excluded from the model because it was subsumed by year fixed effects. The model also controls for market-to-book ratio (MTB), size computed as log transformation of one plus total assets and institutional ownership (IO). To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (calculated based on robust standard errors). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. *All specification include year and industry fixed effects.*

	Completion FA (%)	Completion DA (%)	Completion Focused FA (%)	Completion Focused DA	Premium 7d Px Completed DA	Premium 7d Px Completed FA	Premium 7d Px Focused Acq.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DLOs *Post	3.637***	4.028**	0.502***	1.924***	1.046***	0.190**	0.339**
	(2.976)	(2.399)	(2.584)	(2.798)	(3.579)	(2.394)	(2.545)
DLOs	0.045	1.862	0.057	-0.939*	-0.240	-0.040	-0.052
	(0.054)	(1.389)	(0.578)	(-1.828)	(-1.331)	(-0.986)	(-0.643)
Size	1.915***	2.528***	0.065**	0.578***	0.392***	0.076***	0.136***
	(9.603)	(8.284)	(2.255)	(4.691)	(7.107)	(5.571)	(5.248)
MTB	-0.066	-0.061	-0.008	0.007	0.024**	-0.000	0.009
	(-0.927)	(-0.639)	(-0.848)	(0.142)	(2.122)	(-0.157)	(1.565)
IO	0.032***	0.041***	0.001	0.009*	-0.003	-0.001**	-0.001
	(3.703)	(3.029)	(0.763)	(1.807)	(-1.583)	(-2.130)	(-0.867)
N	6220	6220	6220	6220	6220	6220	6220
adj. R-sq	0.078	0.063	0.010	0.037	0.032	0.015	0.024

In terms of merger premium, Table 14 shows that the DLO group pays significantly higher premium to targets than the non-DLO group. The higher premium persists when the acquisitions are broken down by domestic acquisitions, foreign acquisitions, and focused acquisitions. [7]

IV. 5. Performance: – DLO Firms vs. Control Firms

IV. 5.1. Association between innovation efficiency and performance

Given the significantly better innovation efficiency of the dual group, it is expected that this group will outperform the non-dual group. We employ the Fama-MacBeth (1973) cross-sectional regression in which the dependent variables are ROA and M/B in year t+1 and explanatory variables are geometric growth of patent innovation efficiency (GIE Pat), citation innovation efficiency (GIE Cite), scope innovation efficiency (GIE Scope) and geometric growth of total number of patent as well as exploratory number of patents.

Table 15, Panel A shows that associations between innovation efficiency measures and performance measures are positive. With respect to operating performance, 1% increase in geometric growth of the patent efficiency will result in an increase of ROA by 2.558 (at the 5% significance level), and 1% increase in the cite and scope efficiency would bring about an increase in ROA by 0.783 (at the 5% significance level) and 1.078 (at the 5% significance level) respectively. Similarly, one percent increase of targets' geometric growth of patent and exploration ratio would augment M/B by 0.164 (at the 1% significance level) and 3.847 (at the 5% significance level) respectively.

[7] Our results reported in columns (5) through (8) are qualitatively same using premia with respect to the target's average stock price 90 days prior to the acquisition announcement.

Table 15. Panel A: Post-dual Performance of DLOs and Innovation Efficiency: DLOs Firms.

This table reports estimated average innovative efficiency and post activism performance. The Tables consist of two panels, DLOs firms (Panel A) and Control firm (Panel B). The average slopes estimated following Fama and MacBeth (1973) cross-sectional regressions. The dependent variables are ROA and M/B in year t+1 and explanatory variables are geometric growth of patent innovation efficiency (GIE Pat), citation innovation efficiency (GIE Cite), scope innovation efficiency (GIE Scope) and geometric growth of total number of patent as well as exploratory number of patents. The explanatory variables expressed in percentages. The explanatory and control variables are measured in year t from 2007 to 2014 and include post activism period. ΔROA is the change in ROA between year t and year t – 1. MTB is market to book assets. CapEx (capital expenditure) and R&D (expenditure on research and development) divided by lagged total assets. Industry dummy is based on the Fama and French (1997) 49 industries classification. Average R-squred is the time-series average of the R-squared from the annual cross-sectional regressions. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (based on adjusted standard errors for heteroskedasticity and serial correlations following Newey and West, 1987). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	ROA	M/B	ROA	M/B	ROA	M/B	ROA	M/B	ROA	M/B
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GIE Pat (%)	2.558**	102.515								
	(3.608)	(1.001)								
GIE Cite (%)			0.783**	52.564						
			(2.902)	(1.859)						
GIE Scope (%)					1.078**	102.988				
					(2.881)	(1.342)				
GPat (%)							0.005*	0.164***		
							(2.515)	(4.647)		
GExplore (%)									0.232	3.847**
									(1.790)	(3.253)
ΔROA	0.001		0.001		0.001		0.001		0.001	
	(1.280)		(1.216)		(1.259)		(1.211)		(0.993)	
M/B	0.000		0.000		0.000		0.000		0.000	
	(0.172)		(0.154)		(0.160)		(0.079)		(0.195)	
R&D	-0.193	0.735	-0.192	0.974	-0.189	0.882	-0.242	-0.935	-0.220	0.029
	(-0.901)	(0.204)	(-0.892)	(0.294)	(-0.883)	(0.257)	(-1.218)	(-0.275)	(-1.206)	(0.008)
CAPX	0.111	-2.444	0.111	-2.309	0.110	-2.276	0.120*	-2.081	0.125*	-2.018
	(1.894)	(-0.917)	(1.896)	(-0.862)	(1.868)	(-0.849)	(2.200)	(-0.756)	(2.288)	(-0.749)
IO	-0.000**	-0.009	-0.000**	-0.008	-0.000**	-0.008	-0.000**	-0.007	-0.000**	-0.008
	(-2.620)	(-0.612)	(-2.645)	(-0.588)	(-2.630)	(-0.565)	(-2.760)	(-0.521)	(-3.120)	(-0.596)
ΔTA	-0.080*	1.018	-0.081*	0.904	-0.080*	0.871	-0.084**	1.124	-0.082**	0.997
	(-2.433)	(0.434)	(-2.369)	(0.383)	(-2.383)	(0.366)	(-3.056)	(0.478)	(-3.253)	(0.432)
ΔROE		-0.021		-0.025		-0.021		-0.021		-0.020
		(-0.343)		(-0.430)		(-0.346)		(-0.347)		(-0.323)
Average R-sq	0.434	0.383	0.435	0.383	0.433	0.383	0.447	0.382	0.452	0.380

Table 15. Panel B: Post-dual Performance and Innovation Efficiency: Control Firms. This table reports estimated average innovative efficiency and post activism performance. The average slopes estimated following Fama and MacBeth (1973) cross-sectional regressions. The dependent variables are ROA and M/B in year t+1 and explanatory variables are geometric growth of patent innovation efficiency (GIE Pat), citation innovation efficiency (GIE Cite), scope innovation efficiency (GIE Scope) and geometric growth of total number of patent as well as exploratory number of patents. The explanatory variables expressed in percentages. The explanatory and control variables are measured in year t from 2007 to 2014 and include post activism period. ΔROA is the change in ROA between year t and year t – 1. MTB is market to book assets. CapEx (capital expenditure) and R&D (expenditure on research and development) divided by lagged total assets. Industry dummy is based on the Fama and French (1997) 49 industries classification. Average R-squred is the time-series average of the R-squared from the annual cross-sectional regressions. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics are reported in parenthesis (based on adjusted standard errors for heteroskedasticity and serial correlations following Newey and West, 1987). Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	ROA	M/B	ROA	M/B	ROA	M/B	ROA	M/B	ROA	M/B
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GIE Pat (%)	-2.939	-189.912								
	(-1.340)	(-0.941)								
GIE Cite (%)			1.868*	-110.351*						
			(2.054)	(-2.563)						
GIE Scope (%)					2.039	-216.583				
					(1.186)	(-1.943)				
GPat (%)							-0.015	-0.498		
							(-0.908)	(-1.174)		
GExplore (%)									-0.450	11.969
									(-1.320)	(0.672)
ΔROA	-0.001		-0.001		-0.001		-0.001		-0.001	
	(-0.239)		(-0.233)		(-0.275)		(-0.436)		(-0.198)	
M/B	0.003		0.003		0.003		0.003		0.003	
	(0.567)		(0.648)		(0.674)		(0.686)		(0.667)	
R&D	-1.434***	18.180***	-1.469***	19.213***	-1.497***	19.805***	-1.520***	17.786***	-1.431***	18.243***
	(-16.083)	(8.762)	(-17.584)	(9.477)	(-18.626)	(7.673)	(-9.583)	(10.207)	(-16.182)	(12.080)
CAPX	0.226**	0.832	0.220**	1.265	0.221**	0.881	0.201***	1.470	0.248**	2.633
	(2.965)	(0.445)	(2.825)	(0.708)	(2.852)	(0.477)	(4.503)	(0.792)	(2.950)	(1.136)
IO	0.001	0.004	0.001	0.005	0.001	0.004	0.001	0.006*	0.001	0.007*
	(1.866)	(0.902)	(1.920)	(1.171)	(1.918)	(1.027)	(1.871)	(2.090)	(1.853)	(2.017)
ΔTA	-0.012	-1.286	-0.010	-1.370	-0.012	-1.225	-0.012	-1.308	-0.013	-1.423
	(-0.415)	(-0.701)	(-0.329)	(-0.729)	(-0.413)	(-0.660)	(-0.416)	(-0.704)	(-0.438)	(-0.790)
ΔROE		0.049		0.045		0.049		0.048		0.066
		(1.090)		(0.949)		(1.064)		(1.070)		(1.163)
Average R-sq	0.614	0.465	0.614	0.465	0.616	0.477	0.615	0.453	0.610	0.454

Panel B of Table 15 reports the time series average estimates for control firms in the post-dual period. Panel B shows that only geometric growth of citation efficiency is significantly related to ROA and M/B. However, its effect on ROA is positive (e.g., 1% increase in geometric growth of citation efficiency is associated with an increase in ROA of control firms by 1.868 (significant at the 10% level), while its effect on M/B (significantly negative at the 10% level).

In summing up the results of Table 15, the performance of DLO firms is superior to that of control firms in the post-dual period and relation between innovation and both performance measures are positive. The association between innovation and performance for the control firms is mixed---a positive relation with ROA but negative relation with M/B. As reported in Table 6 above, although DLO firms outperform control firms in the pre-dual period in terms of ROA, their market performance (M/B) is not significantly different from the control group. We attribute this discrepancy to market's underreaction to the information content of innovation efficiency (see, Hirshleifer et al. 2013). It appears the initial underreaction has subsequently given way to positive reaction.

IV. 5.2. Monthly returns in the post-dual period

To assess whether innovation efficiency along with other innovation measures predict return, we estimate the Fama-MacBeth (1973) regression. The dependent variable is monthly excess return (return with dividends – monthly risk-free rate) in year t+1 and expressed in percentages. Explanatory variables are geometric growth of patent innovation efficiency (GIE Pat), citation innovation efficiency (GIE Cite), scope innovation efficiency (GIE Scope) and geometric growth of total number of patent as well as exploratory number of patents.

Table 16: (Panel A): Post-dual Excess Return and DLOs' Innovation Efficiency. This table reports estimated average innovative efficiency and post activism excess monthly return. The Tables consist of two panels, DLOs firms (Panel A) and Control firms (Panel B). The average slopes estimated following Fama and MacBeth (1973) cross-sectional regressions. The dependent variable is monthly excess return (return with dividends – monthly risk-free rate) in year t+1 and expressed in percentages. Explanatory variables are geometric growth of patent innovation efficiency (GIE Pat), citation innovation efficiency (GIE Cite), scope innovation efficiency (GIE Scope) and geometric growth of total number of patent as well as exploratory number of patents. The explanatory and control variables are measured in year t from 2007 to 2014 and include post activism period. ΔROA is the change in ROA between year t and year t – 1. MTB is market to book assets. CapEx (capital expenditure) and R&D (expenditure on research and development) divided by lagged total assets. Volume is the average daily dollar trading volume from the preceding year. CRet is cumulative average return over the past 12 months skipping the recent month. Industry dummy is based on the Fama and French (1997) 49 industries classification. Average R-squred is the time-series average of the R-squared from the annual cross-sectional regressions. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics (based on adjusted standard errors for heteroskedasticity and serial correlations following Newey and West, 1987) are reported in parenthesis. Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)
GIE Pat	2.563***				
	(5.218)				
GIE Cite		0.956***			
		(2.839)			
GIE Scope			2.692***		
			(2.762)		
GPat				0.003**	
				(2.253)	
GExplore					0.136**
					(2.527)
Log(1+ME)	-0.539**	-0.506*	-0.507*	-0.599**	-0.590**
	(-2.060)	(-1.960)	(-1.947)	(-2.210)	(-2.159)
Volume	0.000***	0.000***	0.000***	0.000***	0.000***
	(4.072)	(3.877)	(3.963)	(3.942)	(3.894)
M/B	0.092**	0.090**	0.092**	0.099**	0.101**
	(2.435)	(2.419)	(2.402)	(2.583)	(2.567)
ΔROE	-0.182**	-0.189**	-0.190**	-0.189**	-0.187**
	(-2.162)	(-2.233)	(-2.269)	(-2.157)	(-2.181)
R&D	-9.858**	-8.455*	-8.959*	-11.721**	-11.034**
	(-2.141)	(-1.830)	(-1.924)	(-2.274)	(-2.211)
CAPX	-11.940*	-12.676*	-12.248*	-14.581**	-14.031**
	(-1.849)	(-1.954)	(-1.895)	(-2.143)	(-2.085)
IO	0.025***	0.028***	0.027***	0.028***	0.027***
	(3.606)	(4.476)	(4.229)	(4.440)	(4.168)
CRet	3.620***	3.663***	3.669***	3.670***	3.700***
	(4.003)	(4.008)	(3.969)	(3.910)	(3.975)
ΔTA	-1.069	-1.381	-1.417	-1.215	-0.783
	(-0.684)	(-0.890)	(-0.911)	(-0.730)	(-0.455)
R-sq	0.430	0.434	0.433	0.437	0.438

Table 16 (Panel B): Post-dual Excess Return and Controls' Innovation Efficiency. This table reports estimated average innovative efficiency and post activism excess monthly return of control firms. The average slopes estimated following Fama and MacBeth (1973) cross-sectional regressions. The dependent variable is monthly excess return (return with dividends – monthly risk-free rate) in year t+1 and expressed in percentages. Explanatory variables are geometric growth of patent innovation efficiency (GIE Pat), citation innovation efficiency (GIE Cite), scope innovation efficiency (GIE Scope) and geometric growth of total number of patent as well as exploratory number of patents. The explanatory and control variables are measured in year t from 2007 to 2014 and include post activism period. ΔROA is the change in ROA between year t and year t – 1. MTB is market to book assets. CapEx (capital expenditure) and R&D (expenditure on research and development) divided by lagged total assets. Volume is the average daily dollar trading volume from the preceding year. CRet is cumulative average return over the past 12 months skipping the recent month. Industry dummy is based on the Fama and French (1997) 49 industries classification. Average R-squred is the time-series average of the R-squared from the annual cross-sectional regressions. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics (based on adjusted standard errors for heteroskedasticity and serial correlations following Newey and West, 1987) are reported in parenthesis. Upper-asterisks *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)
GIE Pat	-2.257				
	(-0.833)				
GIE Cite		-3.661			
		(-0.810)			
GIE Scope			-0.168		
			(-0.066)		
GPat				0.041***	
				(3.171)	
GExplore					1.520
					(1.498)
Log(1+ME)	-0.463**	-0.464**	-0.482**	-0.559**	-0.513**
	(-2.141)	(-2.180)	(-2.219)	(-2.207)	(-2.142)
Volume	0.000**	0.000**	0.000**	0.000*	-0.000**
	(2.030)	(2.057)	(2.114)	(1.966)	(-1.998)
M/B	0.270	0.305*	0.307*	0.305	0.580**
	(1.533)	(1.756)	(1.786)	(1.584)	(2.128)
ΔROE	0.337**	0.337**	0.341**	0.397**	0.341*
	(2.065)	(2.070)	(2.110)	(2.085)	(1.939)
R&D	-36.190***	-37.798***	-39.633***	-35.824**	-17.043**
	(-3.177)	(-3.344)	(-3.506)	(-2.448)	(-2.136)
CAPX	25.848	25.479	25.812	30.166	34.751*
	(1.597)	(1.569)	(1.590)	(1.593)	(1.686)
IO	0.019	0.017	0.018	0.018	0.034**
	(1.286)	(1.126)	(1.201)	(1.244)	(2.413)
CRet	1.050*	0.979*	1.155*	1.176*	0.910
	(1.784)	(1.755)	(1.978)	(1.906)	(1.459)
ΔTA	-1.739	-1.503	-1.412	-2.875**	-2.484
	(-1.150)	(-0.956)	(-0.936)	(-2.089)	(-1.655)
R-sq	0.489	0.488	0.487	0.497	0.497

Panel A of Table 16 reports that time series average estimates and t-statistics for DLO firms. For example, one unit increase in geometric growth of patent efficiency will increase excess return by 2.563% (at the 1% significance level), one unit increase in geometric growth of citations will increase excess return by 0.956 (at the 1% significance level), one unit increase in geometric growth of patent scope efficiency will increase excess return by 2.692 (at the 1% significance level) , one unit increase in geometric growth of patent number will increase excess return by 0.003 (at the 5% significant level) and one unit increase in exploration ratio will increase excess return by 0.136 (at the 5% significance level).

Panel B presents results for the control firms by employing the same model as in Panel A above. The results show that only increase in geometric growth of number of patent is significant for control firms with the coefficient of 0.041 (at the 1% significance level). Overall, target firms exhibit a consistently positive relation between all measures of innovation and excess returns, with efficiency measures having the highest coefficient.

IV. 5.3. Innovation and stock return-long-term

This section analyzes whether the DLOs have skills for building strategy based on pre-innovative performance that would predict superior future performance. First, we assess whether innovation efficiency along with other innovation measures predict return, we estimate the Fama-MacBeth (1973) regression. Our results from pre-period (Table A3) and post-period (Table 16) suggest that measures of innovation efficiency and measures of firm exploration strategy convey significant information for stock predictability: these results are consistent with Hirshleifer et al. 2013. Then, we analyze long term strategy of the DLO firms relative to their control counterparts in both pre- and post- periods using the abnormal stock returns. In particular, we estimate the four-factor Fama-French-Carhart model and three-factor Fama-French models as follows:

We use calendar-time portfolios of DLO firms and control firms that rebalance monthly starting at June of event year and holding for the 36 moths. Following Hirshleifer et al 2013, we form portfolios using double sort. We first sort firms into small and big based on the NYSE median size break points. We also perform further sort into Low, Medium and High values of IE based on 75 and 25 percentiles over three years following the event. Finally, we compute the monthly size adjusted value-weighted return.

Table 17, Panel A reports abnormal return prior to dual ownership, while Panel B presents post-dual period. Table 17 shows that both excess and risk-adjusted abnormal returns decrease monotonically with IE in the pre-period, while in the post-post period this pattern is reverse only for the DLOs firms.

Panel A further shows that DLO firms have significantly lower risk adjusted abnormal returns in the pre-dual period. The risk adjusted return monotonically decreases from low IE portfolio to high IE portfolio. These results are consistent across both models. We define strategy as shorting the low IE portfolio of control firms and simultaneously buying and holding for 36 months targets' high IE portfolio. The strategy results in significantly lower returns. For example, using the Carhart four-factor (Fama-French three factor) model the strategy will yield significantly -1.174% monthly risk adjusted return (-0.572%). Furthermore, difference between DLO firms' and control firms' HL strategies yield significantly abnormal risk adjusted return of -0.609 (Carhart four-factor model).

In contrast, Panel B shows that the targets' high IE portfolio has significantly positive risk adjusted monthly abnormal returns of 0.491% (Carhart four-factor model) and 0.489% (Fama-French three-factor model) following DLOs ownership.

Table 17. Panel A: Pre-Dual Innovative Efficiency (IE) and Risk Factor Models. This table illustrates the capability of IE to predict the risk adjusted return. We first sort firms into small (S) and big (B) based on the NYSE median size break points. We also perform further sort into Low (L), Medium (M) and High (H) values of IE based on 75 and 25 percentiles over three years following the event in year t. Then we hold portfolio over three years starting at the end of June of year t-3 (Panel A, three-year pre-event window) and t+1(Panel B, three-year post-event window) and compute the monthly size adjusted value-weighted return for the both periods. We adjust the monthly value-weighted return as taking average of Big (B) and Small (S) within each of IE group (e.g. (S/L+B/L)/2, (S/M+B/M)/2, (S/H+B/H)/2). This table reports average excess return (columns 1 and 2) in percent and alpha (α) from Carhart four-factor model (column 4 and 5) and alpha (α) from Fama-French three factor model (columns 7 and 8). The excess return is defined as difference between value-weighted size adjusted monthly return and the one-month Treasury bill rate. The excess return and alpha are expressed in percentages. We use the following factors: MOM, the momentum factor of Carhart (1997); MKT, HML, SMB factors of Fama and French (1993); IE is computed following Hirshleifer et al. (2013). Robust t-statistics, computed following Newey and West (1987) using six legs, are presented in parentheses.

	Excess Return			Carhart four-factor model			Fama-French three factor model		
	DLOs	Control	DLOs-Control	DLOs (α)	Control (α)	DLOs-Control	DLOs (α)	Control (α)	DLOs-Control
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Low	1.753***	1.883***	-0.129	0.485***	0.462***	0.024	0.487***	0.464***	0.022
	(18.001)	(19.966)	(-0.955)	(3.898)	(4.978)	(0.201)	(3.914)	(5.034)	(0.189)
Medium	1.055***	1.438***	-0.383**	-0.200	-0.120	-0.079	-0.199	-0.122	-0.077
	(9.044)	(14.486)	(-2.501)	(-1.067)	(-1.211)	(-0.360)	(-1.064)	(-1.223)	(-0.350)
High	0.278**	0.936***	-0.658***	-0.689***	-0.103	-0.586*	-0.108	-1.182***	-0.588*
	(2.246)	(6.345)	(-3.438)	(-3.306)	(-0.489)	(-1.887)	(-0.508)	(-4.366)	(-1.887)
H-L	-1.475***	-0.993***	-0.482**	-1.174***	-0.565**	-0.609*	-0.572**	0.022	-0.610*
	(-14.201)	(-9.705)	(-3.296)	(-4.379)	(-2.441)	(-1.726)	(-2.461)	(0.189)	(-1.722)

Table 17. Panel B: Post-Dual Innovative Efficiency (IE) and Risk Factor Models. The excess return, alpha and loading factors are expressed in percentages. This panel reports excess return and risk-adjusted return form the improve IE. Heteroskedasticity-robust t-statistics are reported in parentheses. IE is computed following Hirshleifer et al. (2013). Robust t-statistics, computed following Newey and West (1987) using six legs, are presented in parentheses.

	Excess Return			Carhart four-factor model			Fama-French three factor model		
	DLOs	Control	DLOs-Control	DLOs (α)	Control (α)	DLOs-Control	DLOs (α)	Control (α)	DLOs-Control
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Low	1.417***	1.607***	-0.191	-0.325***	-0.379***	0.054	-0.329***	-0.379***	0.050
	(11.744)	(15.680)	(-1.010)	(-3.189)	(-4.925)	(0.726)	(-3.023)	(-4.911)	(0.632)
Medium	1.109***	1.481***	-0.371**	-0.237**	-0.103	-0.134	-0.236**	-0.105	-0.131
	(10.550)	(13.348)	(-2.317)	(-2.037)	(-1.118)	(-0.925)	(-2.029)	(-1.121)	(-0.900)
High	2.201***	.956***	1.245***	0.491**	-0.906***	1.397***	0.489**	-0.908***	1.397***
	(15.039)	(6.325)	(5.135)	(2.496)	(-4.527)	(5.244)	(2.471)	(-4.521)	(5.254)
H-L	0.754***	-0.544***	1.298***	0.816***	-0.527**	1.343***	0.818***	-0.529**	1.347***
	(8.6951)	(-4.646)	(8.909)	(3.627)	(-2.116)	(4.648)	(3.639)	(-2.122)	(4.660)

The difference between HL strategy of Targets' portfolio and Controls' portfolio in the post-period yields significantly positive risk adjusted return of 1.343% (Carhart four-factor model) and 1.347% (Fama-French three-factor model). Overall our results presented in Table 17 qualitatively similar to results from portfolio in exploration strategy (Table A4).

VI. Conclusion

Most US MNCs maintain a large amount of cash holdings abroad to avoid repatriation tax. According to Harford, Wang & Zhang (2017), the maintenance of such high cash balances overseas leads to inefficiencies in the internal capital markets which in turn cause distortions in the investment decisions of these firms (i.e., domestic underinvestment and foreign overinvestments). Hedge funds owns common shares in many of these MNCs but invests in both stocks and bonds in only some of them.

What motivates hedge funds to take dual positions and how do they go about targeting these firms? Harford, Wang & Zhang (2017) suggest that the higher the repatriation tax, borrowing costs and agency problems, the higher are the investment distortions. Thus, we propose that hedge funds take dual positions in those firms that are exposed to these problems and, therefore, present greater potential for success in the long term.

In this paper, we demonstrate that dual owners target those MNCs that have higher repatriation tax costs than the rest (i.e., firms with higher proportion of income tied to foreign income that are generated from higher number of subsidiaries in the tax haven countries. The managers of dual firms are more entrenched as they have more restrictive anti-takeover provisions. Hedge funds invest in bonds of these firms to provide external funding in order for these funds to improve their efficiency in domestic investments. Upon gaining dual ownership, hedge funds

engage in wresting control away from the existing management by reducing insider trading, engaging in proxy contests and fighting anti-takeover provision. These measures are associated with improved capital market resulting in enhanced efficiency in investments, especially investments in innovation. Finally, to address the agency problems related to foreign cash holdings, hedge funds engage dual-owned firms into acquiring foreign firms that provide synergy.

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Chapter 2

Innovation Strategies & IPO Underpricing

I. Introduction

The IPO pricing is largely determined by the relative bargaining power of the issuer and underwriter, or their ability to persuade the other side to set an offer price on their terms. Would innovative issuers have a higher bargaining power if their past innovation strategies could signal their future success? This question is important, since a majority of the recent US initial public offerings (IPOs) are technological firms, which face a high, positive first day return or underpricing phenomenon. Moreover, patent portfolio may signal a firm's future success when a firm is patenting their products and not infringing intellectual rights of its competitors.

In the equilibrium, relative bargaining power of underwriters and issuers determines the size of IPO underpricing.[8] If the outcome of an IPO is more certain to underwriters, then they may demand a lower portion of the total proceeds to offset their risk. Thus, we posit that issuers have bargaining power when they can affect the competitive environment of underwriters, and influence underwriters' ability to achieve profitability. If powerful issuers can negotiate a higher offer price, the issuer is indifferent to non-price dimensions of the IPO process. The issuers may switch an underwriter to compensate their low bargaining power with analyst coverage.[9] All of this contributes to the underwriters' costs. A powerful issuer can increase profit potential for

[8] In the Nash equilibrium, both underwriter and issuer maximize their objective function, but neither underwriter nor issuer can increase their return by neglecting each player maximization faction. The relative barging power of both underwriter and issuer determines the share of the total proceeds for each player (Hu and Ritter, 2007).

[9] Krigman, Shaw and Womack (2001) find little evidence of switching underwriters due to dissatisfaction and suggest two reasons why issuers may switch underwriters. First, issuers upgrade to higher reputation underwriters. Second, issuers strategically buy additional and influential coverage from the lead underwriter.

underwriters. The underwriter offering stock of a powerful innovative issuer may set public offering price higher than on stocks of issuers with relatively low power. On the other hand, a weak issuer, one who is at the mercy of the underwriter in terms of cost and riskiness of innovative portfolio, makes the underwriter less competitive, and decreases potential profit for the underwriter.

We show that choosing the explorative Pre-IPO innovation strategy empowers an innovative issuer in negotiation for a higher offer price. First, we show that innovation power significantly increases price adjustment and reduces IPO underpricing. The results suggest that firms with a greater innovation power have a greater bargaining position relative to firms with a lower innovation power and that those firms complete the IPO process faster with larger size of stocks offered relative to the date of the initial offer.

Furthermore, we find that the firms with higher explorative inventions in their portfolio experience a higher degree of bargain power. The bargaining power of those firms is manifested in a higher price revision, greater adjustment to the size of final offer, and smaller amount of money left on the table. Our finding is in line with the existing IPO literature that suggests that firms with an explorative strategy would more likely exercise their option to withdraw and would hire multiple bookrunners. In contrast, the opposite is true for the firms with higher exploitative inventions.

Finally, our study shows that following the IPO, analysts are bearish on the explorative portfolios for an issuer with the positive price adjustment, while bullish on the exploitative portfolios for firms with the negative price adjustments. We find that innovation power does not significantly impact the deviation of analyst prediction of the price to earnings ratio (P/E), while we find a significant negative relation for the explorative portfolios, and a significant positive

relation for the exploitative. This finding suggests that the analyst lust hypothesis is consistent with exploitative strategies. Our finding suggests that analyst coverage boosts the market price of firms with exploitative strategies.

Our paper uses two measures of pre-IPO innovation strategies, which may differentiate between explorative and exploitative issuer bargain power. First, we introduce the measure of innovation power, which is based on the value of innovation relative to the whole technological space. We ascertain the value of innovation in terms of the potential to stimulate further innovations and patents according to the respective technological classes. We quantify issuers' innovation power based on the number of forward citations, which reference the patents belonging to the firm's patent portfolio. The innovation power is constructed according to technological classes and with respect to competitors in the same technological space.

An illustration of an issuer with high bargaining power is Zynga and Pandora. Corresponding to our measure of innovation power, both Zynga and Pandora have high innovation power, which belongs to the firms in the top five percentile of innovation power in our sample. Both Zynga and Pandora have a positive offer price revision above the midpoint offer price, and a small first day return (less than 9%). A successful business model secured with a portfolio of patents may provide an issuer with a choice of an underwriter, as well as the power to negotiate a higher offer price. As Pandora's decacorn competitor, Spotify would not choose to directly list its offer on the New York Stock Exchange, if it would not have a relative advantage, such as a more exclusive streaming platform.

We construct our second measure following existing innovation literature (e.g. Levinthal and March, 1993; Manso, 2011; Smith and Tushman, 2005; Uotila, Maula, Keil, and Zahra, 2009) in categorizing issuing firms based on the strategic orientation in terms of the exploitative versus

the explorative nature of a patent portfolio[10]. Exploitative firms are in possession of patent(s) that rely on prior innovations, developments, and established platforms in the same technological class. Such firms are less risky (March, 1991; Henderson, 1993; Levinthal and March, 1993). In contrast, the explorative type of issuer relies on developments across technological classes and requires more resources to develop and implement a new technology or invention.

Explorative innovation involves new knowledge, advanced knowledge, and/or existing knowledge different from the inventor's, which stem from the firm's current patent portfolio. Therefore, such issuers are riskier than the exploitative issuers (Ahuja et al., 2001). To quantify the effect of explorative versus exploitative margins of an issuer's innovation portfolio, we rely on the quantity and diversity of patent technological classes cited in the issuer's patent portfolio. In contrast to the innovation power, we use a number of backward patent citations across technological classes, which appear in an issuer's patents, to quantify the exploratory margin of the firm's innovation portfolio. Similarly, we use a number of backward patent citations within the issuer's technological class which appears in the firm's patents to quantify the exploitative margin of the firm's innovation patent portfolio. A higher portion of exploitative patents in the portfolio would signal a firm's ability to improve current products. In contrast, the higher proportion of explorative patents in the portfolio would signal a firm's ability to develop new products.

In this paper, we posit that the pure exploitative strategy positively relates to issuer valuations while pure explorative strategy would be negatively related to valuation due to a higher degree of uncertainty. According to March (1991) and Uotila et al (2009), exploration improves a firm's ability to adapt to environmental changes, meanwhile increasing the firm's uncertainty,

[10] Throughout the paper we interchangeably use terms "firm with exploratory nature of patent portfolio" and "explorative firm"; "firm with exploitative nature of patent portfolio" and "exploitative firm".

and sacrificing short-term firm performance. That is why we explore a firm's innovative portfolio as a mix of explorative and exploitative innovation. Thus, we expect that a firm with a strategy more focused on exploration will provide higher bargaining power since it will signal the firm's future growth.

Our study differs from the existing literature. First, we explore pre-IPO innovation strategy and its impact on IPO price formation, while other studies either explore post-IPO innovation strategies (e.g. Aggarwal and Hsu, 2013; Bernstein, 2015) or explore strategies of private firms relative to public firms (e.g. Gao, Hsu and Li, 2018, who exclude firms which went public during their sample period to control for firm intention to go public). Second, our study focuses on the issuers' side of the negotiation process; in contrast a large body of research addresses the agency problems during the IPO process as well as underpricing due to the bargaining power of the underwriters [11].

II. Hypothesis Development

As in any principal-agent problem, the underwriter (the agent) acts in his or her best interests unless the issuing firm (the principle) has an instrument which allows it to control or motivate the underwriter to act according to the interests of the issuing firm. Unless the issuing firm exercises its bargaining power with the underwriter, it may have limited control over the negotiation process in general and in determining the initial price in particular. Previous studies

[11] Baron (1979, 1982), Biais et al. (2002), Loughran and Ritter (2002), and others demonstrate agency conflict between underwriters and issuers. Based on models with asymmetric information Ritter and Welsh (2002) and Ritter (2011) argue that market structure incentivizes the underwriters to underprice. Krigman et al. (1999) demonstrate that underwriters misprice the security intentionally because they face no direct penalties. Reuter (2006) provides evidence that lead underwriters are able to "capture dollars left on the table." Chen and Ritter (2000) show that underwriters directly benefit from IPO in the form of spreads.

demonstrate that the issuing firms are able to influence IPO pricing through options, such as withdrawing in pre-IPO market (Busaba et al., 2001), switching to more reputable underwriters (Krigman, Shaw, and Womack, 1999; Carter, 1992; Ljungqvist and Wilhelm, 2005), initiating price revisions (Ince, 2014), granting pre-IPO insider ownership stakes (Ljungqvist and Wilhelm, 2003), and enhancing visibility and enlisting multiple lead underwriters (Jeon et al., 2015). In the same vein, Hu and Ritter, 2007, argue that having multiple bookrunners gives the issuers relative advantage in negotiations.

The Bargaining Hypothesis theorizes that an issuer and an underwriter both have different motives in the issue pricings, and the offer price is an outcome of the negotiation between both parties. Literature on issuer bargaining power posits the positive relation between the bargaining power and the offer price. For instance, Loughran and Ritter (2002) postulate the prospect theory based model, which can be transformed into a bargaining model, where underwriters have an appetite for a lower offer price, while issuing firms crave a higher offer price. The theory argues that during preselling period issuing firms negotiate more aggressively when demand is unexpectedly weak. In the same vein, costly negotiation hypothesis, proposed by Harris (1991), suggests that the frequency of rounded prices increases in both the stock price and uncertainty concerning an issue valuation. Bradley et al. (2004) complement the former study and find only two consistent effects, the integer effect and the partial price adjustment effect.

The above hypothesis suggests that the bargaining power is positively related to an offer price revision when issuers have the relative advantage in negotiation. We posit that an issuer's innovation strategy is a channel of persuading underwriters about a value of the firm's business model, its prospects of growth, and ability to remain competitive. In particular, we expect that more explorative innovation will signal the prospective firm growth while more exploitative

inventions will project more certain payoff. The IPO literature also suggests that the offer price adjustment is inversely related to underpricing (e.g. Hanley, 1993).

Therefore, we hypothesize the following:

H1. Issuing firms with stronger innovation power or stronger explorative (exploitative) innovation strategy should result in larger (smaller) positive offer price adjustment and should result in larger (smaller) underpricing.

The underwriters would be more willing to adjust the offer price upward if the explorative strategy of an issuer signals substantial demand on the issue. The issuers with more explorative strategies may bargain a higher offer price when underwriters anticipate stronger demand from investors – a guarantee to compensate for a risk. Sherman (1992) shows that the investors' demand will be low when an issuer's project will not be profitable. Thus, this issue must be underpriced because to sustain investors' demand on this issue the investors must be compensated for the cost of acquiring information.

H2. Issuing firms with stronger innovation power or stronger explorative (exploitative) innovation strategy can lead to an increase (decrease) in the amount of stock demanded.

Another strand of literature connects the registration period to bargaining power. For instance, Barcaskey (2005) shows that stronger negotiations by an issuing firm lead to a longer registration period due to re-affirmation of investors demand at the new price. Çolak & Günay, (2011) formulate a game theoretic model to demonstrate why some top-notch firms may strategically postpone their initial public offering. The model suggests that the top-notch issuers have substantially higher median delayed days since the beginning of the IPO cycle than the lower quality issuers.

The optimal timing of the IPO relies upon both valuation levels and uncertainty of the option-like features of going public (Busaba, 2006). Pastor and Veronesi (2005) demonstrate that the novel innovations are symbolized by high uncertainty about their future yield, and that the time-varying nature of this uncertainty can also cause the observed stock price patterns. Those works are supported by Bouis, (2009), who shows that issuers with the high stock market valuation go public faster. Thus, we expect that a firm with the more explorative innovation portfolio negotiates the higher offer price longer due to higher uncertainty. Thus, we hypothesize the following:

H3. Innovative issuers with a more explorative innovation strategy will negotiate a higher offer price slower than the issuers with a more exploitative innovation strategy.

Ljungqvist and Wilhelm (2003)'s realignment of the incentives hypothesis also can be redesigned in terms of the bargaining theory. This study suggests that the issuers with greater uncertainty when receiving a negative feedback during book building would be likely to withdraw and those firms are very probable to benefit from information acquisition during bookbuilding (Benveniste and Spindt, 1989). Moreover, issuers' option to withdraw from the IPO process fortifies their bargain power (Busaba, Benveniste and Guo 2001). Thus, we posit the following hypothesis:

H4. Innovative issuer with higher explorative (exploitative) innovation strategy is more (less) likely to withdraw from the IPO process.

Next, we hypothesize that the explorative innovation strategy of issuers is positively related to multiple bookrunners. In particular, the bargaining hypothesis suggests that multiple book runners give issuers power in negotiation (Hu and Ritter, 2007). This power is explained by

competition among underwriters, who compete for mandate. The competition leads to greater analyst coverage and greater underwriter effort and lower cost.

H5. Innovative issuers with higher explorative innovation are more likely to hire multiple book runners while issuers with more exploitative innovation are less likely to hire more than one bookrunner.

Next, we link an underwriter's ability to predict successful IPO issues to innovation strategy. Liu and Ritter (2011) modeled the supply side of IPO underwriting, where underwriter bargaining power arises from the issuing firm's need in research coverage by influential analysts. The authors also argue that underwriter power stems from these analysts. The innovation strategy can raise an issuer's bargaining power relative to an underwriter's by facilitating prediction of future operation performance and allowing underwriters to assess potential risk and demand on issuer stock, thus limiting underwriter's costs of non-price dimensions. Alternatively, the innovation strategy might lower an issuer's bargaining power relative to an underwriter's by boosting the underwriter's costs due to higher risk or relative lower demand on issuer stock.

Finally, we hypothesize that an issuer with more power over underwriters will not place emphasis on analyst coverage in the post-IPO period to boost its stock price. Loughran and Ritter (2004) argue that issuers emphasize on hiring underwriters with influential analysts and with excessive underpricing reputation. Literature on IPO underpricing illustrates that the bullish analyst recommendations can be significant for the insiders desiring to sell their stocks in the open market following post-IPO closure of the lock-up period (e.g. Chen and Ritter (2000) and Aggarwal, Krigman, and Womack (2002)). In addition, in the post IPO period the issuing firms compensate for influential analysts by being willing to leave money on the table (Bradley, Jordan, and Ritter (2003); Cliff and Denis (2003)). Thus, we hypothesize the following:

H6. Innovative issuers with higher explorative (exploitative) innovation strategy will experience a lower (higher) number of bullish analyst recommendations and a lower (higher) deviation of the forecasted P/E from the actual P/E for the same period.

III. Methodology and Data

3.1. Variable Construction

To derive IPO-related variables, such as underpricing, price revision, proceeds, and venture capital, the number of bookrunners is derived using data from the SDC Platinum dataset while innovation measures, such as the number of patents, innovation power, and explorative patent ratio, are derived using data from the USPTO dataset. Appendix C provides definitions of the variables. A more detailed description of innovation measures such as number of patents, explorative patent ratio, explorative firms, and innovation power is provided below.

Number of Patents.

The number of patents is the total number of patent counts during the pre-IPO period.

Explorative Patent Ratio.

To distinguish between explorative and exploitative firms we first measure the share of knowledge used from outside of the firm's technological class and not utilized from existing knowledge within the firm. The share of knowledge is the percentage of backward citations made by the given patent class i to patent class j. The total number of patents cited at the IPC 4-digit patent technological class is contained in the patents cited by the given patent i.

A patent i is categorized as "exploratory" if the percentage of citations made, which corresponds to the outside of firm i's existing expertise, is greater than the median value of the

existing expertise of a corresponding technological class. The average median values of expertise outside of a corresponding cited patent technological class is 79%.

Innovation Power

Theory that competition stimulates innovations and that a firm's technological advantage can effectively counteract monopolistic power dates back to the work of Schumpeter (1934). Evans and Schmalensee (2002) argue that technological firms pursue Schumpeterian type of competition [12] in the marketplace by competing through innovation rather than through prices. We argue that having more valuable technology relative to its peers gives the issuing firm negotiation power during the IPO underwriting process. To measure the relative value of the firm's innovation portfolio, we assume that the number of citations referring to the firm's patent(s) can serve as the proxy for the value of the firm's innovation portfolio. The greater the number of citations of the firm's patents, the greater the value of the firm's innovation portfolio (Trajtenberg, 1990; Hall et al., 2005).

To measure the value of a firm's innovation portfolio, we construct a continuous measure of the deviation of a firm's innovation portfolio composition from its corresponding technological space. A firm's patent portfolio is constructed to represent its decomposition into eleven value categories (bins) across 35 technological classes based on the distribution of the latest seven years of forward citations. We define technological space as the universe of all firms which innovate (have at least one patent) in a corresponding technological class (IPC class). A matrix element contains the number of the latest seven years of forward citations that is assigned based on its

[12] Schumpeterian competition is a continuous destructive process driven by innovation, which leads to greater economic growth than steadier traditional alternatives (Hovenkamp, 2008). Furthermore Nicholas (2003), suggests that innovation market power may prevail over industry through creative destruction and market power stems from rapid technological evolution.

distribution in the corresponding technological class. Thus, we compare each firm's portfolio in terms of an eleven by thirty-five matrix (eleven value bins by thirty-five technological classes) to the corresponding matrix of the whole technological space.

Previous studies such as Hoberg, Phillips & Prabhala, 2014; Bena and Li 2014; Jaffe, 1989, etc., apply separation or uncentered correlation to measure distance between a pair of two firms, i and j. Following established methodology, we calculate an issuer's innovation power as simply the dot product between its own innovation portfolio ($TI_{i,k,t}$) and the whole corresponding space $\left(TI_{j,k,t}\right)$ as follows:

$$Innovation\ Power_{i,j} \equiv \left\langle TI_{i,k,t}.\frac{TI_{j,k,t}}{||TI_{j,k,t}||}\right\rangle, \qquad (2)$$

where $TI_{i,k,t}$ denotes a vector of length v by k, where v denotes eleven value bins of firm i's patent portfolio that belongs to class k at time t. In contrast, $TI_{j,k,t}$ denotes a vector of length v by k, where v is the eleven value bins of corresponding technological space of firm i's class k and time t. $TI_{i,k,t}$ measures a firm's composition level of its patent portfolio value, while $TI_{j,k,t}$ measures the composition of the patent portfolio value at the technological space level. We construct the eleven value bins of the $TI_{i,k,t}$ and $TI_{j,k,t}$ by categorizing a firms patent portfolio into eleven groups based on the distribution of the total number of citations during the seven preceding years in each of 35 technological classes as follows: category one (breakthrough invention) includes self-citations and citations that belong in the 99th percentile of citation distribution; category two (important invention) includes firms with a number of citations that falls between 95% and 98% of citation distribution; category three includes firms with citations that fall between

90% and 94% of citation distribution; category four includes firms with a number of citations that falls between 85% and 89% of citation distribution; category five includes firms with a number of citations that falls between 80% and 84% of citation distribution; category six includes firms with a number of citations that falls between 75% and 79% of citation distribution; category seven includes firms with a number of citations that falls between 70% and 74% of citation distribution; category eight includes firms with a number of citations that falls between 65% and 69% of citation distribution; category nine includes firms with a number of citations that falls between 60% and 64% of citation distribution; category ten includes firms with a number of citations that falls between 50% and 59% of citation distribution; and category eleven (low value) includes firms with a number of citations falls below 49% of citation distribution. The number of self-citations is included in the first bucket since self-citations are more valuable than citations from exterior citations (Hall et al., 2005).

Innovation Power$_{i,t}$ is a continuous value larger than zero. The higher the value of a firm's innovation power, the closer a firm's value of its patent portfolio to the value of all patents in the corresponding technological space. It has the minimum value of zero for firms whose value of their patent portfolios is uncorrelated to the corresponding technological space. A firm with a value closer to the value of the whole corresponding technological space poses a greater degree of innovation power, because its patent portfolio has a greater number of citations relative to its peers in corresponding technological space. The position of each firm i in year t is determined by whole technological space.

3.2. Data Sources

Our sample includes the US companies that went public from January 1986 to December 2012. We use various sources to compile our final sample. Initial Public Offering (IPO) data is

from the Security Data Company New Issues database (SDC). Our patent data is from the USPTO, which provides information on the number of granted patents, dates of initial application and granting, as well as details on the patents itself and the applicants. Patent categories are based on the International Patent Classification (IPC). Finally, we obtained total assets from Compustat and daily securities prices are from the daily CRSP dataset. Missing values of closing prices at the end of the first trading day and midpoint price ranges are replaced with corresponding values from either CRSP or Bloomberg[13].

Following Ritter and Welch (2002) we impose standard filters and exclude IPOs with an offer price below $5.00 per share, unit offers, real estate investment trusts (REITs), closed-end-funds, banks, savings and loan associations (S&Ls) and special purpose acquisition companies (SPACs). We also require companies to have non-missing information on total assets and exclude financial firms with SIC codes between 6000 and 6999. To be included in our sample and be categorized as an innovative firm, a firm should have at least one granted patent anytime between the founding date[14] and December of 2012. For a robustness check we use measures from Kogan et al (2017). These measures are constructed in terms of dollar amounts and are available for the period from 1926 to 2010.

Our final sample of innovative firms consists of 1,097 unique innovative firms. Table 1 demonstrates that at the time of IPO innovative firms are on average 8.44 years old, have on average 1.2 bookrunners, and 4.12 cumulative number of patents. On average IPOs of innovative

[13] Bloomberg's global equity offerings database covers of about 43,000 IPOs and over 43,000 additional offerings. It also covers more than 500 financial advisors and 500 legal advisors.
[14] The founding year is the year a company was founded. Data on founding dates was obtained from J. Ritter web page.

firms in our sample exhibit first-day underpricing of 26.40%. Average innovation power of these firms is 2.54.

Table 1. Summary Statistics. This table summarizes dependent and explanatory variables. The dependent variables are first day return (underpricing) and price revision. The explanatory variables are Innovation Power, ExR and ExT ratios. Where ExT (ExR) ratio is the variable that measures the proportion of the cumulative number of Exploitative (Explorative) patents in the total cumulative number of a firm's patents at the time of IPO (Patents). Innovation Power is a continuous variable greater than zero, which measures an issuer's eleven innovation value portfolios to all peers in its technological space. The venture capital variable is an indicator variable taking the value of one if the IPO is backed by venture capital, otherwise it is zero (Venture capital). Age at IPO is log transformation of one plus the number of years since the founding date of the firm (Log(1+Age)) and log transformation of one plus total assets in millions of USD (Log(1+Assets)). Log transformation of one plus proceeds (Log(1+Proceeds)) defined as the number of shares offered times the share price scaled by total assets in millions of USD. The number of bookrunners is the number of managers responsible for the bookrunner's role (No. of bookrunners). Cumulative expanses on research and development in USD scaled by total assets (R&D). Sales in USD scaled by total assets. The positive first day return variable is an indicatory variable taking the value of one if the first day return is positive, otherwise it is zero (Positive 1d Return). To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles.

	N	Mean	StdDev	p25	Median	p75
Underpricing	1097	0.264	0.466	0.008	0.115	0.322
Price Revision	851	0.007	0.198	-0.111	0.000	0.128
Patents	1097	4.119	3.607	2.000	3.000	5.000
Patents ExR	1097	1.780	3.213	0.000	0.000	2.000
Patents ExT	1097	2.827	4.778	0.000	1.000	4.000
Innovation Power	1097	2.537	4.249	0.228	0.810	2.229
ExT	1097	0.554	0.479	0.000	1.000	1.000
ExT Dollar	921	0.567	0.481	0.000	1.000	1.000
ExR	1097	0.446	0.479	0.000	0.000	1.000
ExR Dollar	921	0.433	0.481	0.000	0.000	1.000
Venture capital	1097	0.667	0.471	0.000	1.000	1.000
Log(1+Age)	1097	2.245	0.843	1.792	2.079	2.639
Log(1+Proceeds)	1097	0.509	0.239	0.349	0.492	0.623
No. of bookrunners	1097	1.199	0.539	1.000	1.000	1.000
R&D	1097	0.304	0.308	0.091	0.215	0.394
Sales	1097	0.658	0.611	0.146	0.538	0.992
Positive 1d Return	1097	0.771	0.420	1.000	1.000	1.000
Top Tier	1097	0.589	0.492	0.000	1.000	1.000
Log(1+Assets)	1097	4.454	1.357	3.630	4.305	5.106

Appendix D presents the pairwise Pearson correlation coefficients for our innovation measures. It demonstrates that the correlation between the ExR ratio and the ExR Dollar ratio is 98.4% and correlation between the ExT ratio and ExT Dollar ratio is also at the level of 98.4%. The high correlations suggest that ExR ratio (ExT ratio) is a good proxy for ExR Dollar (ExT Dollar) ratio. In contrast, Innovation power is weakly correlated with the ExR ratio with the coefficient of -0.096% and p-value at the level 0.752.

IV. Empirical Results

4.1. Innovation strategy and underpricing

The IPO literature (e.g. Hanley, 1993 and Kutsuna, Smith and Smith ,2009) documents positive relation between the revision in the offer price to the positive first day return. Thus, to account for jumps in first-day price due to revision of the offer price upward, we include price revision into the underpricing equation (Table 2).

In the Columns 4 - 9 of Table 2, we find that the coefficient estimates on the ExR (ExT) ratio, is statistically significant. ExR(ExT) ratio, which measures composition of the innovation portfolio within the firm boundary. Given the sign of these coefficient estimates, the increase in ExR ratio decreases underpricing, while the increase in ExT ratio increases underpricing. These findings are robust using ExR and ExT ratios measured using Kogan's et al (2015) dollar value of innovation. We cluster all standard errors from all models at the industry level[15].

[15] We use Fama French 10 industries for all our analysis following Bernstein, (2015). Moreover, our results are consistent using more disaggregate industry levels (e.g. FF12, FF17 and FF38).

The underpricing (first-day return) consists of two components such as the final offer price and the first-day closing price. The latter can be affected by either offer price revisions (e.g. when prices are adjusted upwards and information is revealed through high demand for the issue, then the first-day price will exceed the offer price) or by market assessment of uncertainty. This suggests that there is an optimal mix of innovations, which can result in the efficient first-day closing price. Diversification of the innovation portfolio decreases the issuer's level of underpricing. March (1991) and Uotila et al (2009) point out that firms need to balance their exploration and exploitation activities.

What type of innovation strategy would lead to minimum and maximum underpricing? What proportion of each innovation strategy would lead to lower underpricing? To answer those questions, we test for an optimal portfolio using U-shaped approach. First, we add to the preceding models both the level term of ExR (ExT) ratio and the squared terms of ExR (ExT) ratio, implying that the optimal blend of exploration and exploitation exists. Then we apply methodology of Lind and Mehlum (2010) to test for U-shape relation between underpricing and ExR(ExT) ratio. The test results are reported in the Panel C of Table 2. The test revealed a significant inverted U-shape relation.

Lind and Mehlum's (2010) approach allow us to assess whether the extreme point is within the upper and lower bounds by estimating confidence intervals at the extreme points. Confidence intervals within the bounds of the low and high levels of ExR (ExT) ratio provide evidence of an inverted U-shaped relationship. The estimated extreme point (using specification with industry and year fixed effects) is 0.434 (0.590), which is within the upper and lower bounds of ExR (ExT) [0.384(0.384); -0.501(-0.267)], providing strong support for an inverted U-shaped relationship between ExR (ExT) and underpricing.

Table 2: (Panel A): Innovation Strategy and Underpricing. *This table reports the relationship between IPO underpricing (first-day returns) and various measures of issuer innovativeness. The dependent variable is underpricing. The explanatory variables are Innovation Power, ExR and ExT ratios. Where ExR (ExT) ratio is the variable that the measures proportion of the cumulative number of Explorative (Exploitative) patents in the total cumulative number of a firm's patents at the time of IPO. Innovation Power is a continuous variable greater than 0, which measures an issuer's eleven innovation value portfolios to all peers in its technological space. The venture capital variable is an indicator variable taking the value of one if the IPO is backed by venture capital, otherwise it is zero (Venture capital). Age at IPO is log transformation of one plus the number of years since the founding date of the firm (Log(1+Age)) and log transformation of one plus total assets in millions of USD (Log(1+Assets)). Log transformation of one plus proceeds (Log(1+Proceeds)) defined as the number of shares offered times the share price scaled by total assets in millions of USD. No. of bookrunners is the number of bookrunners responsible for the bookrunner's role. Cumulative expanses on research and development in USD scaled by total assets (R&D). Sales in USD scaled by total assets. The positive first day return variable is an indicatory variable taking the value of one if the first day return is positive, otherwise it is zero (Positive 1d Return). The* Price Revision *is the price revision from the midpoint of the initial filing range to the offer price, relative to the midpoint price. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Innovation Power	0.002	-0.005***	-0.004***						
	(1.351)	(-4.783)	(-3.467)						
ExR				-0.050***	-0.055***	-0.052***			
				(-4.279)	(-4.979)	(-4.463)			
ExT							0.050***	0.055***	0.052***
							(4.279)	(4.979)	(4.463)
Venture capital	0.032	0.029	0.028	0.034	0.031*	0.031	0.034	0.031*	0.031
	(1.103)	(1.493)	(1.022)	(1.195)	(1.847)	(1.194)	(1.195)	(1.847)	(1.194)
Log(1+Age)	-0.021*	-0.028**	-0.023**	-0.020*	-0.029**	-0.023**	-0.020*	-0.029**	-0.023**
	(-1.967)	(-3.209)	(-2.524)	(-1.849)	(-3.073)	(-2.365)	(-1.849)	(-3.073)	(-2.365)
Log(1+Proceeds)	0.161*	0.050	0.063	0.163*	0.052	0.065	0.163*	0.052	0.065
	(2.097)	(1.116)	(1.526)	(2.215)	(1.301)	(1.755)	(2.215)	(1.301)	(1.755)
No. of bookrunners	-0.072*	0.014	0.021	-0.075*	0.003	0.011	-0.075*	0.003	0.011
	(-1.887)	(0.328)	(0.486)	(-1.969)	(0.066)	(0.253)	(-1.969)	(0.066)	(0.253)
R&D	0.023	-0.038	-0.004	0.030	-0.046	-0.009	0.030	-0.046	-0.009
	(0.790)	(-1.256)	(-0.146)	(0.957)	(-1.385)	(-0.308)	(0.957)	(-1.385)	(-0.308)
Sales	-0.089*	-0.009	-0.043	-0.092*	-0.012	-0.046	-0.092*	-0.012	-0.046
	(-2.096)	(-0.256)	(-1.524)	(-2.127)	(-0.325)	(-1.609)	(-2.127)	(-0.325)	(-1.609)
Log(1+Assets)	0.051**	0.023	0.020	0.054**	0.022	0.020	0.054**	0.022	0.020
	(2.756)	(1.450)	(1.204)	(2.851)	(1.462)	(1.223)	(2.851)	(1.462)	(1.223)
Top Tier	0.023	0.021	0.022	0.025	0.025	0.025	0.025	0.025	0.025
	(0.611)	(0.675)	(0.668)	(0.661)	(0.823)	(0.775)	(0.661)	(0.823)	(0.775)
Price Revision	0.731***	0.762***	0.724***	0.730***	0.744***	0.709***	0.730***	0.744***	0.709***
	(3.508)	(3.578)	(3.304)	(3.465)	(3.490)	(3.252)	(3.465)	(3.490)	(3.252)
N	851	851	851	851	851	851	851	851	851
adj. R-sq	0.238	0.297	0.305	0.241	0.299	0.308	0.241	0.299	0.308
Industry FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

Table 2 (Panel B): Innovation Strategy and Underpricing. This table reports the relationship between IPO underpricing (first-day returns) and various measures of issuer innovativeness using the dollar value of patents from Kogan et al (2015). The dependent variable is underpricing. The explanatory variables are ExR Dollar and ExT Dollar ratios. The Positive Adjustment is an indicator variable, which takes a value of one if an issuer experiences positive price adjustment and zero otherwise. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
ExR Dollar	-0.067***	-0.072***	-0.069***			
	(-3.992)	(-4.298)	(-3.721)			
ExT Dollar				0.067***	0.072***	0.069***
				(3.992)	(4.298)	(3.721)
Venture capital	0.022	0.022	0.021	0.022	0.022	0.021
	(0.794)	(0.930)	(0.697)	(0.794)	(0.930)	(0.697)
Log(1+Age)	-0.033*	-0.039**	-0.033*	-0.033*	-0.039**	-0.033*
	(-2.056)	(-2.731)	(-2.084)	(-2.056)	(-2.731)	(-2.084)
Log(1+Proceeds)	0.165	0.043	0.059	0.165	0.043	0.059
	(1.683)	(0.690)	(1.013)	(1.683)	(0.690)	(1.013)
No. of bookrunners	-0.053	-0.016	-0.001	-0.053	-0.016	-0.001
	(-1.194)	(-0.228)	(-0.020)	(-1.194)	(-0.228)	(-0.020)
R&D	0.052	-0.042	0.000	0.052	-0.042	0.000
	(1.490)	(-1.091)	(0.008)	(1.490)	(-1.091)	(0.008)
Sales	-0.100*	-0.016	-0.053	-0.100*	-0.016	-0.053
	(-2.225)	(-0.439)	(-1.742)	(-2.225)	(-0.439)	(-1.742)
Log(1+Assets)	0.053*	0.019	0.018	0.053*	0.019	0.018
	(2.249)	(0.930)	(0.814)	(2.249)	(0.930)	(0.814)
Top Tier	0.026	0.021	0.021	0.026	0.021	0.021
	(0.659)	(0.764)	(0.733)	(0.659)	(0.764)	(0.733)
Price Revision	0.760***	0.773***	0.736***	0.760***	0.773***	0.736***
	(4.088)	(3.958)	(3.715)	(4.088)	(3.958)	(3.715)
N	742	742	742	742	742	742
adj. R-sq	0.248	0.305	0.313	0.248	0.305	0.313
Industry FE	Yes	No	Yes	Yes	No	Yes
Year FE	No	Yes	Yes	No	Yes	Yes

Panel C. Test of U-shape relation between Underpricing and Explorative (Exploitative) ratios. This panel reports upper and lower slopes and t statistics using Lind & Mehlum, (2010) U-test. The coefficients for U-test were obtained from the linear model models specified in the panel A and panel B but with inclusion in each specification an addition variable such as the square term of *ExR (ExT)* ratio. We also test U-shape relation using Kogan's et al (2015) dollar value of patents such as *ExR Dollar* and *ExT Dollar* ratios.

	ExR				***ExR Dollar***			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Extreme	0.429	0.425	0.436	0.434	0.445	0.442	0.445	0.443
Slope Lower Bound	0.362	0.322	0.419	0.384	0.597	0.524	0.591	0.539
Slope Upper Bound	-0.482	-0.436	-0.542	-0.501	-0.745	-0.660	-0.735	-0.678
t-statistics	3.000	2.110	3.940	2.750	2.340	1.810	2.670	2.030
p-value	0.008	0.032	0.002	0.011	0.022	0.052	0.013	0.036
	ExT				***ExT Dollar***			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Extreme	0.599	0.607	0.586	0.590	0.571	0.575	0.570	0.574
Slope Lower Bound	0.362	0.322	0.419	0.384	0.597	0.524	0.591	0.539
Slope Upper Bound	-0.242	-0.209	-0.296	-0.267	-0.448	-0.387	-0.446	-0.400
t-statistics	2.650	1.720	3.910	2.530	1.990	1.510	2.290	1.720
p-value	0.013	0.060	0.002	0.016	0.039	0.083	0.024	0.060
Industry FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	No	No	Yes	Yes	No	No	Yes	Yes

Should be noted that the lower bound for both ExR and ExT are the same at all specifications, while the upper bound is about twice lower for ExR suggesting that the addition of explorative innovation decreases underpricing. The same approach revealed (unreported) that the pure explorative patent portfolio has a U-shape relation with underpricing while the pure exploitative patent portfolio has an inverted U-shape relation. Overall, the ExR (ExT) ratio level at which underpricing reaches the maximum is 43%(59%). These results confirm that a higher proportion of ExR ratio in an innovation portfolio leads to less effort of an issuer to curb underpricing.

Our second variable of interest is innovation power, which defines a firm's position in the technological space relative to its peers. The higher the index, the greater the uniqueness of the firm's innovation portfolio which essentially is determined by the distribution of the firm is forward citation in its technological class[16]. The difference between Innovation Power and ExR ratio is in that the former measures the position of a firm among its peers, which is outside of the firm's boundary. From our regression analysis in Columns 1 - 3 of Table 2 Panel A, we find that as Innovation Power increases, firms experience less underpricing. Such positive relation is statistically significant at 1% in two out of the three specifications. When the market is efficient, less underpricing implies an offering price that is closer to the market valuation (i.e. first-day closing price). We interpret that as Innovation Power creating strong bargaining power for the issuers. As summarized in Ritter and Welch (2002), the issuers and underwriters bargain over the offering price. Because of the advantageous position of knowledge, the powerful issuer has more flexibility of revealing information to the underwriters. In such cases, the negotiation between the issuer and the underwriters goes in favor of the issuer.

[16] For more details on variable construction, please refer to Section 2.

Thus, our evidence on underpricing suggests that the underpricing is a by-product of the negotiation. The market significantly reacts to various stages of negotiations, which facilitate information transfer with further reflection in underpricing (Giammarino and Lewis, 1988). However, underpricing can mean a lot more than bargaining power. Thus, we extend our analysis to other aspects of IPO in order to strengthen the argument of bargaining power.

4.2. Innovation strategy and price revision

Another angle of the effect of innovation portfolio on the offering price is to examine price revision. Benveniste and Spindt (1989), Hanley (1993) documented a positive relation between a price revision in the pre-issue period and the underpricing. They argue that the final offer price only partially accommodates new private information from the demand, with the rest of the adjustment coming in the form of underpricing. Unlike those earlier papers, Ljungqvist and Wilhelm (2003) address the question of price revision from the perspective of the agency problem between issuers and underwriters. They interpret such partial adjustment as price range being an unconditional expectation of the issuers' true value, and the offer price being the conditional estimate of the true value that is conditional on a variety of the firms' characteristics and insiders' incentives to bargain over the IPO offering price. In our context, controlling for all other characteristics, the degree that issuers can bargain against underwriters depends on the issuers' innovation portfolio. Our results on price revision are reported in Table 3.

Similar to our discussions in Table 2, we look at both the issuers' Innovation Power that depends on the relativeness to the peers and their ExR ratio that is within the firm's boundary. From Table 3, Columns 1 - 3, we find out that increases in Innovation Power are positively related to a price revision.

Table 3 (Panel A). Innovation Strategy and Price Revision. The dependent variable in regression is the price revision from the midpoint of the initial filing range to the offer price, relative to the midpoint price. We predict a positive relation between price revisions and the measures of innovativeness of an issuer. The explanatory variables are Innovation Power, ExR and ExT ratios. Where ExR (ExT) ratio is the variable that measures the proportion of the cumulative number of Explorative (Exploitative) patents in the total cumulative number of a firm's patents at the time of IPO. Innovation Power is a continuous variable greater than 0, which measures an issuer's eleven innovation value portfolios to all peers in its technological space. The venture capital variable is an indicator variable taking the value of one if the IPO is backed by venture capital, otherwise it is zero (Venture capital). Age at IPO is log transformation of one plus the number of years since the founding date of the firm (Log(1+Age)) and log transformation of one plus total assets in millions of USD (Log(1+Assets)). Log transformation of one plus proceeds (Log(1+Proceeds)) defined as the number of shares offered times the share price scaled by total assets in millions of USD. No. of bookrunners is the number of bookrunners responsible for the bookrunner's role. Cumulative expanses on research and development in USD scaled by total assets (R&D). Sales in USD scaled by total assets. The positive first day return variable is an indicatory variable taking the value of one if the first day return is positive, otherwise it is zero (Positive 1d Return). The Positive Adjustment is an indicator variable, which takes value of one if an issuer experiences positive price adjustment and zero otherwise. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Innovation Power	0.005***	0.005***	0.005***						
	(5.090)	(5.073)	(4.285)						
ExT				-0.018***	-0.017***	-0.019***			
				(-4.093)	(-3.984)	(-4.536)			
ExR							0.018***	0.017***	0.019***
							(4.093)	(3.984)	(4.536)
Venture capital	0.031	0.021	0.017	0.032	0.021	0.017	0.032	0.021	0.017
	(1.419)	(0.965)	(1.043)	(1.487)	(1.000)	(1.063)	(1.487)	(1.000)	(1.063)
Log(1+Age)	-0.026**	-0.021**	-0.022*	-0.025**	-0.021**	-0.021*	-0.025**	-0.021**	-0.021*
	(-2.787)	(-2.264)	(-1.951)	(-2.816)	(-2.297)	(-1.929)	(-2.816)	(-2.297)	(-1.929)
Log(1+Proceeds)	0.246***	0.247***	0.249***	0.246***	0.247***	0.249***	0.246***	0.247***	0.249***
	(7.225)	(7.459)	(6.712)	(6.667)	(6.912)	(6.355)	(6.667)	(6.912)	(6.355)
No. of bookrunners	-0.028***	-0.029***	-0.056**	-0.026***	-0.027***	-0.055**	-0.026***	-0.027***	-0.055**
	(-4.741)	(-5.218)	(-2.490)	(-4.684)	(-5.168)	(-2.392)	(-4.684)	(-5.168)	(-2.392)
R&D	-0.199***	-0.193***	-0.175***	-0.190***	-0.185***	-0.168***	-0.190***	-0.185***	-0.168***
	(-7.865)	(-7.633)	(-6.681)	(-7.904)	(-7.671)	(-6.611)	(-7.904)	(-7.671)	(-6.611)
Sales	-0.006	-0.019	-0.022	-0.007	-0.019	-0.023	-0.007	-0.019	-0.023
	(-0.389)	(-0.989)	(-1.195)	(-0.472)	(-1.018)	(-1.252)	(-0.472)	(-1.018)	(-1.252)
Positive 1d Return	0.104***	0.100***	0.105***	0.105***	0.100***	0.106***	0.105***	0.100***	0.106***
	(3.378)	(3.364)	(4.016)	(3.428)	(3.416)	(4.091)	(3.428)	(3.416)	(4.091)
Log(1+Assets)	0.050***	0.050***	0.052***	0.053***	0.053***	0.055***	0.053***	0.053***	0.055***
	(4.589)	(4.610)	(3.884)	(4.572)	(4.603)	(3.965)	(4.572)	(4.603)	(3.965)
Top Tier	0.017	0.016	0.009	0.016	0.016	0.008	0.016	0.016	0.008
	(1.254)	(1.172)	(0.762)	(1.093)	(1.018)	(0.573)	(1.093)	(1.018)	(0.573)
Walk-Up	0.009	-0.008	-0.066	0.021	0.005	-0.052	0.021	0.005	-0.052
	(0.500)	(-0.513)	(-1.589)	(1.056)	(0.260)	(-1.167)	(1.056)	(0.260)	(-1.167)
N	851	851	851	851	851	851	851	851	851
adj. R-sq	0.218	0.227	0.241	0.213	0.221	0.234	0.213	0.221	0.234
Industry FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year FE	No	No	Yes	No	No	Yes	No	No	Yes

Table 3 (Panel B). Innovation Strategy and Price Revision. This table uses dollar value of patents from Kogan et al (2015). The dependent variable is price revision. The explanatory variables are ExR Dollar and ExT Dollar ratios. The Positive Adjustment is an indicator variable, which takes a value of one if an issuer experiences positive price adjustment and zero otherwise. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
ExT Dollar	-0.013**	-0.010**	-0.011**			
	(-2.886)	(-2.456)	(-2.870)			
ExR Dollar				0.013**	0.010**	0.011**
				(2.886)	(2.456)	(2.870)
Venture capital	0.028*	0.019	0.015	0.028*	0.019	0.015
	(1.836)	(1.212)	(1.301)	(1.836)	(1.212)	(1.301)
Log(1+Age)	-0.025*	-0.023	-0.022	-0.025*	-0.023	-0.022
	(-2.099)	(-1.816)	(-1.582)	(-2.099)	(-1.816)	(-1.582)
Log(1+Proceeds)	0.256***	0.256***	0.258***	0.256***	0.256***	0.258***
	(5.476)	(5.423)	(5.488)	(5.476)	(5.423)	(5.488)
No. of bookrunners	-0.029**	-0.027**	-0.019*	-0.029**	-0.027**	-0.019*
	(-2.334)	(-2.548)	(-1.842)	(-2.334)	(-2.548)	(-1.842)
R&D	-0.184***	-0.179***	-0.156***	-0.184***	-0.179***	-0.156***
	(-8.789)	(-8.410)	(-7.518)	(-8.789)	(-8.410)	(-7.518)
Sales	-0.006	-0.019	-0.026	-0.006	-0.019	-0.026
	(-0.428)	(-1.028)	(-1.380)	(-0.428)	(-1.028)	(-1.380)
Positive 1d Return	0.113***	0.109***	0.113***	0.113***	0.109***	0.113***
	(5.089)	(5.273)	(5.790)	(5.089)	(5.273)	(5.790)
Log(1+Assets)	0.058***	0.058***	0.061***	0.058***	0.058***	0.061***
	(4.003)	(4.011)	(3.590)	(4.003)	(4.011)	(3.590)
Top Tier	0.007	0.007	0.004	0.007	0.007	0.004
	(0.412)	(0.419)	(0.254)	(0.412)	(0.419)	(0.254)
Walk-Up	0.016	0.002	-0.069	0.016	0.002	-0.069
	(0.972)	(0.088)	(-1.453)	(0.972)	(0.088)	(-1.453)
N	742	742	742	742	742	742
adj. R-sq	0.226	0.231	0.244	0.226	0.231	0.244
Industry FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	No	Yes	No	No	Yes

Table 4. Innovation Strategy and Change in Offer Size. This table reports the relationship between change in offer size and various measures of issuer innovativeness. The dependent variable is the change between the size of the offer at the first trading day and initial off offer size (offer size at the begging of the IPO process) with further scaling the change by total assets. The explanatory variables are Innovation Power, ExR and ExT ratios. Where ExR (ExT) ratio is the variable that measures the proportion of the cumulative number of Explorative (Exploitative) patents in the total cumulative number of a firm patents at the time of IPO. Innovation Power is a continuous variable greater than 0, which measures an issuer's eleven innovation value portfolios to all peers in its technological space. The venture capital variable is an indicator variable taking the value of one if the IPO is backed by venture capital, otherwise it is zero (Venture capital). Age at IPO is log transformation of one plus the number of years since the founding date of the firm (Log(1+Age)) and log transformation of one plus total assets in millions of USD (Log(1+Assets)). Log transformation of one plus proceeds (Log(1+Proceeds)) defined as the number of shares offered times the share price scaled by total assets in millions of USD. No. of bookrunners is the number of bookrunners responsible for the bookrunner's role. Sales in USD scaled by total assets. Price Revision is a difference between the final offer price and the mid-price of the original file range with further division of the difference by the mid-price of original file range. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Innovation Power	0.013***	0.008***	0.010***						
	(6.687)	(9.674)	(5.600)						
ExR				0.080**	0.098***	0.090**			
				(2.333)	(3.431)	(3.044)			
ExT							-0.080**	-0.098***	-0.090**
							(-2.333)	(-3.431)	(-3.044)
Price Revision	0.579***	0.656***	0.596***	0.615***	0.678***	0.624***	0.615***	0.678***	0.624***
	(4.982)	(5.336)	(5.796)	(5.364)	(5.597)	(6.179)	(5.364)	(5.597)	(6.179)
No. of bookrunners	0.079**	0.148**	0.133**	0.096***	0.164**	0.150**	0.096***	0.164**	0.150**
	(2.677)	(2.856)	(2.917)	(3.758)	(3.050)	(3.191)	(3.758)	(3.050)	(3.191)
Log(1+Age)	0.168***	0.170***	0.159***	0.172***	0.172***	0.161***	0.172***	0.172***	0.161***
	(6.706)	(10.393)	(9.050)	(6.322)	(9.829)	(8.348)	(6.322)	(9.829)	(8.348)
Sales	0.034	0.103	0.050	0.035	0.108	0.056	0.035	0.108	0.056
	(0.496)	(1.276)	(0.590)	(0.518)	(1.331)	(0.661)	(0.518)	(1.331)	(0.661)
Venture capital	0.110	0.049	0.119	0.106	0.046	0.113	0.106	0.046	0.113
	(1.200)	(0.627)	(1.257)	(1.174)	(0.590)	(1.233)	(1.174)	(0.590)	(1.233)
Top Tier	0.150***	0.165***	0.163***	0.142***	0.158***	0.156***	0.142***	0.158***	0.156***
	(3.566)	(4.949)	(5.073)	(3.698)	(5.161)	(5.366)	(3.698)	(5.161)	(5.366)
N	874	874	874	874	874	874	874	874	874
adj. R-sq	0.138	0.137	0.155	0.136	0.140	0.156	0.136	0.140	0.156
Industry FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

That means that the uniqueness of the issuers in the technological space enables them to bargain more aggressively over the offer price, which is consistent with Ljungqvist and Wilhelm (2003). In addition to Innovation Power, we implement the same models that include the level term of ExR ratio and the level term of ExT ratio in Columns 4 - 6. ExR ratio is significantly and positively related to a price revision, while ExT ratio is significantly and inversely related. Across all models, the positive relation between ExR ratio (Innovation Power) and price revision is well sustained. We therefore conclude that an increase in exploration will magnify issuers' bargaining power over the offering price, while an increase in ExT ratio will lessen an issuer's bargaining power.

Benveniste et al., (2003) show that the cost of information production or compensation for revealing private information in terms of underpricing affects revisions in offer price, and who include average underpricng to control for such effect. In the same vein, Loughran and Ritter (2002) suggest that the skewness of the amount of money left on the table among IPOs with upward price revision should be a high concern only for some issuers. These issuers may wish to deliberately leave money on the table in IPO. Thus, we include a dummy variable that takes value of one if an IPO has a positive first day return and zero when an IPO has negative or zero first day return.

If the explorative strategy of an issuer could signal substantial demand on the issue, the underwriters would be more willing to adjust the offer price upward. Next, we analyze relation of pre-IPO innovation strategy to the adjustment of demand on the issue. We expect that the issuers with more explorative strategies will bargain a higher offer price when underwriters anticipate stronger demand from investors as a guarantee of a risk compensation.

Table 4 analyzes a relation between change in offer size and a firm's innovation power as well as strategy. The dependent variable is the change between the size of the offer at the first trading day and initial offer size (offer size at the begging of the IPO process) with further scaling the change by total assets. This analysis confirms our expectation that explorative innovation strategy is positively related to the adjustment of offer size at significance level 5% using both industry and year firm fixed effects while innovation power is positively related at 1% significance level at all specifications. The exploitative innovation at similar significance as the explorative ratio, but it is inversely related to the change in issue size.

Table 5: Innovation Strategy and Likelihood of Withdrawn. This table reports coefficient estimates from probit models. The dependent variable is equal to one for the withdrawn firms, and zero otherwise. The explanatory variables are Innovation Power, MExR and MExT. Where Innovation Power is a continuous variable greater than 0, which measures an issuer's eleven innovation value portfolios to all peers in its technological space and MExR (MExT) is an indicator variable that takes value one if a firm's ExR (ExT) ratio is greater than industry median value. The venture capital variable is an indicator variable taking the value of one if the IPO is backed by venture capital, otherwise it is zero (Venture capital). Total Shares is defined as the expected total shares (in millions) outstanding after the offering. Shares Filed is defined as offering shares in millions led with SEC. Ret60 is return over the 60-day period after offering. Log transformation of one plus total assets in millions of USD (Log(1+Assets)). Log transformation of one plus proceeds (Log(1+Proceeds)) defined as the number of shares offered times the share price scaled by total assets in millions of USD. Sales in USD scaled by total assets. Price Revision is a difference between the final offer price and the mid-price of original file range with further division the difference by the mid-price of original file range. All variables are defined at Appendix C. All control variables are winsorized at 1% level. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Innovation Power	0.018**	0.015***	0.010**						
	(2.497)	(2.644)	(2.534)						
MExR				1.480***	1.591***	1.824***			
				(6.816)	(3.957)	(7.230)			
MExT							-1.480***	-1.591***	-1.824***
							(-6.816)	(-3.957)	(-7.230)
Top Tier	-0.123	-0.186	-0.195	-0.137	-0.220	-0.204	-0.137	-0.220	-0.204
	(-0.369)	(-0.696)	(-0.599)	(-0.427)	(-0.772)	(-0.625)	(-0.427)	(-0.772)	(-0.625)
Venture capital	0.321**	0.451***	0.345*	0.329**	0.455***	0.344*	0.329**	0.455***	0.344*
	(2.309)	(2.772)	(1.897)	(2.347)	(3.157)	(1.913)	(2.347)	(3.157)	(1.913)
Log(1+Total Shares)	-0.058	-0.710***	-0.718**	-0.022	-0.692***	-0.712**	-0.022	-0.692***	-0.712**
	(-0.105)	(-3.052)	(-2.510)	(-0.037)	(-2.955)	(-2.448)	(-0.037)	(-2.955)	(-2.448)
Log(1+Shares Filed)	0.309	0.327***	0.293**	0.290	0.332**	0.290*	0.290	0.332**	0.290*
	(1.275)	(2.676)	(1.983)	(1.129)	(2.526)	(1.940)	(1.129)	(2.526)	(1.940)
Ret60	-0.034	-0.029	-0.034*	-0.032	-0.024	-0.032*	-0.032	-0.024	-0.032*
	(-1.312)	(-1.210)	(-1.838)	(-1.267)	(-1.084)	(-1.677)	(-1.267)	(-1.084)	(-1.677)
Log(1+Assets)	-0.056	-0.058	0.009	-0.046	-0.027	0.015	-0.046	-0.027	0.015
	(-0.337)	(-0.380)	(0.047)	(-0.277)	(-0.194)	(0.080)	(-0.277)	(-0.194)	(0.080)
Sales	-0.018	-0.084	0.133	-0.017	0.077	0.141	-0.017	0.077	0.141
	(-0.273)	(-0.958)	(0.738)	(-0.241)	(0.664)	(0.768)	(-0.241)	(0.664)	(0.768)
Price Revision	-0.463	-0.530	-0.437	-0.430	-0.461	-0.412	-0.430	-0.461	-0.412
	(-0.666)	(-0.883)	(-0.630)	(-0.606)	(-0.760)	(-0.603)	(-0.606)	(-0.760)	(-0.603)
N	785	764	687	785	764	687	785	764	687
Industry FE	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

Table 5 (Panel B): Innovation Strategy and Likelihood of Withdrawn. This table reports coefficient estimates from probit models. The dependent variable is equal to one for the withdrawn firms, and zero otherwise. This table reports the relationship between IPO underpricing (first-day returns) and various measures of issuer innovativeness using the dollar value of patents from Kogan et al (2015). The explanatory variables are MExR Dollar and MExT Dollar based on measures of Kogan et al (2015). MExR (MExT) Dollar is an indicator variable that takes value one if a firm's ExR (ExT) Dollar ratio is greater than the industry median value. All variables are defined at Appendix C. All control variables are winsorized at 1% level. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MExR Dollar	2.600***	3.056***	2.769***	3.767***				
	(3.498)	(6.816)	(3.825)	(7.230)				
MExT Dollar					-2.600***	-3.056***	-2.769***	-3.767***
					(-3.498)	(-6.816)	(-3.825)	(-7.230)
Top Tier	-0.149	-0.137	-0.218	-0.204	-0.149	-0.137	-0.218	-0.204
	(-0.511)	(-0.427)	(-0.766)	(-0.625)	(-0.511)	(-0.427)	(-0.766)	(-0.625)
Venture capital	0.437***	0.329**	0.437***	0.344*	0.437***	0.329**	0.437***	0.344*
	(3.170)	(2.347)	(3.040)	(1.913)	(3.170)	(2.347)	(3.040)	(1.913)
Log(1+Total Shares)	0.040	-0.022	-0.684***	-0.712**	0.040	-0.022	-0.684***	-0.712**
	(0.080)	(-0.037)	(-2.921)	(-2.448)	(0.080)	(-0.037)	(-2.921)	(-2.448)
Log(1+Shares Filed)	0.279	0.290	0.316**	0.290*	0.279	0.290	0.316**	0.290*
	(1.166)	(1.129)	(2.418)	(1.940)	(1.166)	(1.129)	(2.418)	(1.940)
Ret60	-0.025	-0.032	-0.027	-0.032*	-0.025	-0.032	-0.027	-0.032*
	(-1.048)	(-1.267)	(-1.211)	(-1.677)	(-1.048)	(-1.267)	(-1.211)	(-1.677)
Log(1+Assets)	-0.104	-0.046	-0.023	0.015	-0.104	-0.046	-0.023	0.015
	(-0.738)	(-0.277)	(-0.161)	(0.080)	(-0.738)	(-0.277)	(-0.161)	(0.080)
Sales	-0.056	-0.017	0.063	0.141	-0.056	-0.017	0.063	0.141
	(-1.099)	(-0.241)	(0.579)	(0.768)	(-1.099)	(-0.241)	(0.579)	(0.768)
Price Revision	-0.405	-0.430	-0.481	-0.412	-0.405	-0.430	-0.481	-0.412
	(-0.630)	(-0.606)	(-0.788)	(-0.603)	(-0.630)	(-0.606)	(-0.788)	(-0.603)
N	874	785	764	687	874	785	764	687
Industry FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	No	No	Yes	Yes	No	No	Yes	Yes

Table 6. Predicting the time from first filling date to successful IPO. The time is constructed as the difference between first filling date and date of IPO. The failure in this model is the success of IPO. We define the successful issuer as an issuer, who experienced upward price revision. This table reports coefficient estimates from a hazard model of the time from the first filling to the actual date of IPO. The model is based an exponential hazard distribution. In other words, the model is in accelerated failure time, that is, a negative coefficient estimate indicates the event (successful IPO) happens more quickly. The explanatory variables are Innovation Power, ExR and ExT ratios. Where ExR (ExT) Ratio is variable that measures proportion of the cumulative number of Explorative (Exploitative) patents in the total cumulative number of a firm's patents at the time of IPO. Innovation Power is a continuous variable greater than 0, which measures an issuer's eleven innovation value portfolios to all peers in its technological space. The venture capital variable is an indicator variable taking the value of one if the IPO is backed by venture capital, otherwise it is zero (Venture capital). Age at IPO is log transformation of one plus the number of years since the founding date of the firm (Log(1+Age)) and log transformation of one plus total assets in millions of USD (Log(1+Assets)). Log transformation of one plus proceeds (Log(1+Proceeds)) defined as the number of shares offered times the share price scaled by total assets in millions of USD. No. of bookrunners is the number of bookrunners responsible for the bookrunner's role. Cumulative expanses on research and development in USD scaled by total assets (R&D). Sales in USD scaled by total assets. The positive first day return variable is an indicatory variable taking the value of one if the first day return is positive, otherwise it is zero (Positive 1d Return). To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Innovation Power	-0.017**	-0.019**								
	(-2.323)	(-2.321)								
ExT			-0.097**	-0.089**						
			(-2.413)	(-2.543)						
ExR					0.097**	0.089**				
					(2.413)	(2.543)				
ExT Dollar							-0.133***	-0.119***		
							(-5.448)	(-3.934)		
ExR Dollar									0.133***	0.119***
									(5.448)	(3.934)
Venture capital	0.124	0.063	0.124	0.070	0.124	0.070	0.059	0.016	0.059	0.016
	(1.354)	(0.837)	(1.408)	(0.936)	(1.408)	(0.936)	(0.655)	(0.169)	(0.655)	(0.169)
Log(1+Age)	-0.062	-0.068	-0.059	-0.066	-0.059	-0.066	-0.071	-0.087*	-0.071	-0.087*
	(-0.784)	(-0.879)	(-0.770)	(-0.909)	(-0.770)	(-0.909)	(-1.274)	(-1.839)	(-1.274)	(-1.839)
No. of bookrunners	-0.564***	-0.571***	-0.546***	-0.550***	-0.546***	-0.550***	-0.646***	-0.637***	-0.646***	-0.637***
	(-3.835)	(-3.651)	(-3.645)	(-3.472)	(-3.645)	(-3.472)	(-3.028)	(-2.924)	(-3.028)	(-2.924)
R&D	-1.141***	-1.322***	-1.197***	-1.375***	-1.197***	-1.375***	-1.080***	-1.254***	-1.080***	-1.254***
	(-3.033)	(-3.303)	(-3.143)	(-3.417)	(-3.143)	(-3.417)	(-3.825)	(-4.195)	(-3.825)	(-4.195)
Sales	0.085	0.084	0.075	0.075	0.075	0.075	0.085	0.103	0.085	0.103
	(0.837)	(0.806)	(0.699)	(0.693)	(0.699)	(0.693)	(0.712)	(0.824)	(0.712)	(0.824)
Positive 1d Return	1.286***	1.287***	1.299***	1.302***	1.299***	1.302***	1.391***	1.390***	1.391***	1.390***
	(17.331)	(18.229)	(17.593)	(18.500)	(17.593)	(18.500)	(12.852)	(13.775)	(12.852)	(13.775)
Log(1+Assets)	0.033	0.055	0.015	0.032	0.015	0.032	0.036	0.065	0.036	0.065
	(0.819)	(1.067)	(0.361)	(0.628)	(0.361)	(0.628)	(0.799)	(1.085)	(0.799)	(1.085)
Top Tier	0.084	0.080	0.092	0.091	0.092	0.091	0.142	0.144	0.142	0.144
	(0.901)	(0.928)	(1.033)	(1.127)	(1.033)	(1.127)	(1.256)	(1.370)	(1.256)	(1.370)
No. of subjects	1024	1024	1024	1024	1024	1024	857	857	857	857
No. of failures	367	367	367	367	367	367	318	318	318	318
Industry FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes

4.3. Innovation strategy, withdrawal, and the timing of the IPO process

Lowry and Schwert (2002) address two ways that issuers can influence the IPO process. One is the timing between the filing date and the offer date. The other is the ability of the issuer to cancel the IPO deal. We first tested which firms are more likely to withdraw IPO. The results are reported in Table 5.

We show that Innovation Power has evident impact on issuers' likelihood to cancel their IPO deals. In other words, the real option that issuers can withdraw from the IPO process becomes more valuable as the issuer is more unique in technological space. That is consistent with the findings of Busaba et al (2001) that the option to withdraw strengthens the issuers' bargaining power with respect to investors and underwriters. Likewise, we show the higher level of exploration leads to the largest likelihood of withdrawing. In contrast, a higher level of exploitation decreases the likelihood of withdrawing.

Interestingly, from Columns 1 – 4 of Table 6 Innovation Power and ExT ratio are significantly and negatively related to the speed of IPO completion. In contrast, the ExR ratio is significantly and positively related to the time of IPO completion. Innovation power is the relative innovation value in terms of the capability to generate new inventions, while exploration is the degree of the diversity of knowledge used. Therefore, we conclude that more valuable deals are completed faster. In contrast, explorative firms take a longer time to complete deals than exploitative firms because invention based on new knowledge may require additional information about relative position of the invention in the technological class. Unlike innovation power, the explorative ratio does not take into account relative position of an issuer in the corresponding technological class.

4.4. Post IPO innovation strategy and withdrawn firms. Difference-in-Differences (DiD) framework

In order to enhance the understanding of the importance of exploration-exploitation balance, we are going to assess how the innovation portfolio affects the issuing firms using the difference-in-differences framework. Specifically, we explore the time dimension of the three years preceding IPO and the three years following IPO, and the innovativeness dimension of the firms' exploration and exploitation before and after IPO.

Ferreira et al (2012) model the impact of public and private ownership structure on firms' exploration and exploitation projects. They conclude it is optimal to go public when capitalizing on current ideas and optimal to go private when exploring new ideas. Since both private and public firms need to balance exploration and exploitation in their innovation portfolio, the implication based on Ferreira et al (2012) is that firms with a larger portion of exploration in place are more likely to go public. They show that when firms go public, their managers tend to choose more conventional innovation projects. We support Ferriera's prediction using the DiD approach and results reported in Table 7. In the DiD approach, we adopt the methodology from Bernstein (2015) that incorporates both the firms that successfully went public and the firms that withdrew their IPO filing and remain private.

First, the coefficient estimates on the interaction of "Issuing Firm" and "Post" show that in the three years following IPO the firms that went public are pursuing more exploitative strategies. That confirms Ferriera et al (2012)'s viewpoint that going public makes firms balance out their exploration by more and more exploitation. Going public is a dramatic turning point in a firm's life.

Table 7. The Difference-in-difference Analysis. For each withdrawn firm of an IPO in year t, we select up to five issuing firms based on a randomization process from cohort, which belong to the same industry, same size of assets at time t-1 and close in offer price. Dependent variables are Innovation Power (columns 1 to 3), Explorative ratio (columns 4 to 6) and Exploitative Ratio (columns 7 to 9). The "Issuing Firm" is indicator variable that takes value one if firm successfully went IPO and zero indicates a firm withdrawn from IPO. Both Issuing and Withdrawn Firms are innovative firms. The dummy variable "Post" takes place zero if observations are spanning from three years prior to IPO and take place one if observations running to three years after IPO/withdrawal. Control variables are log transformation of one plus total assets (Log(1+Assets)), log transformation one plus a firm's age (Log(1+Age)) at time of IPO, and HHI index. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Innovation Power	Innovation Power	Innovation Power	ExR	ExR	ExR	ExT	ExT	ExT
*Issuing Firm*Post*	2.077***	1.988***	2.047***	-0.125**	-0.124**	-0.123***	0.125**	0.124**	0.123***
	(4.628)	(4.915)	(5.326)	(-3.063)	(-3.089)	(-4.482)	(3.063)	(3.089)	(4.482)
Issuing Firm	-1.012***	-1.119***	-0.625**	-0.137**	-0.133**	-0.133**	0.137**	0.133**	0.133**
	(-3.921)	(-4.960)	(-2.493)	(-3.078)	(-3.120)	(-3.547)	(3.078)	(3.120)	(3.547)
Post	-0.006	0.146	1.232	-0.727***	-0.727***	-0.722***	0.727***	0.727***	0.722***
	(-0.008)	(0.194)	(1.384)	(-36.519)	(-36.149)	(-48.143)	(36.519)	(36.149)	(48.143)
Log(1+Assets)	0.818***	0.716***	0.462	0.019	0.019	0.019	-0.019	-0.019	-0.019
	(5.323)	(5.729)	(1.717)	(1.409)	(1.239)	(0.890)	(-1.409)	(-1.239)	(-0.890)
Log(1+Age)	0.125	0.160	0.507	-0.003	-0.002	-0.003	0.003	0.002	0.003
	(0.551)	(0.514)	(1.490)	(-0.568)	(-0.236)	(-0.285)	(0.568)	(0.236)	(0.285)
HHI	-4.721**	-4.502**	-0.892	-0.099	-0.082	-0.083	0.099	0.082	0.083
	(-3.297)	(-2.984)	(-0.447)	(-1.536)	(-1.732)	(-1.447)	(1.536)	(1.732)	(1.447)
N	1254	1254	1254	1254	1254	1254	1254	1254	1254
adj. R-sq	0.042	0.049	0.180	0.614	0.617	0.623	0.614	0.617	0.623

Second, negative and significant coefficients on Issuing Firm suggests that on average an issuing firm has lower innovation power and explorative ratio than a withdrawn firm. At the same time an issuing firm has a higher exploitative ratio. This is consistent with the prediction that a withdrawn firm has a higher bargaining power in terms of higher innovation power and exploration ratio.

Overall, our evidence from the DiD analysis suggests why and how IPO is important to firms' strategic decisions on exploration and exploitation. It is largely consistent with neoclassical theories of firm (Maksimovic and Phillips (2013) and Arikan and Stulz (2016)) that when firms have scarce assets (i.e. exploration), acquisition and diversification (i.e. exploitation) are value-increasing because they allow firms to exploit the valuable assets and the growth opportunities provided by those valuable assets.

4.5. Innovation portfolio and Multiple Bookrunners

In this section, we test the prediction that utilizing multiple bookrunners increases issuer bargaining power. This prediction's grounded on Hu and Ritter (2007), who hypothesize that having multiple bookrunners increases issuers' advantage in IPO negotiation. The results are presented in Table 8.

The column 2 of Table 8 shows that the ExT ratio significantly decreases the likelihood of multiple bookrunners while the ExR ratio significantly increases the likelihood of multiple bookrunners. Results are robust using ExT and ExR ratios in dollar amounts. The results support our claim that increases in the ExR ratio lead to increases in bargaining power, while the opposite is true for the ExT ratio.

Table 8. Innovation Strategy and Multiple Bookrunners. This table reports results from logit model, where the dependent variable is an indicator variable, which takes a value of one if an issuer hires more than one bookrunner and zero otherwise. The explanatory variables are Innovation Power, ExR and ExT ratios. Where ExR (ExT) ratio is the variable that measures the proportion of the cumulative number of Explorative (Exploitative) patents in the total cumulative number of a firm patents at the time of IPO. Innovation Power is a continuous variable greater than 0, which measures an issuer's eleven innovation value portfolios to all peers in its technological space. The venture capital variable is an indicator variable taking the value of one if the IPO is backed by venture capital, otherwise it is zero (Venture capital). Age at IPO is log transformation of one plus the number of years since the founding date of the firm (Log(1+Age)) and log transformation of one plus total assets in millions of USD (Log(1+Assets)). Log transformation of one plus proceeds (Log(1+Proceeds)) defined as the number of shares offered times the share price scaled by total assets in millions of USD. No. of bookrunners is the number of bookrunners responsible for the bookrunner's role. Cumulative expanses on research and development in USD scaled by total assets (R&D). Sales in USD scaled by total assets. The positive first day return variable is an indicatory variable taking the value of one if the first day return is positive, otherwise it is zero (Positive 1d Return). To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. *Industry and year fixed effects are included in all specifications.*

	(1)	(2)	(3)	(4)	(5)
Innovation Power	-0.005				
	(-0.116)				
ExT		-0.641***			
		(-3.984)			
ExR			0.641***		
			(3.984)		
ExT Dollar				-0.660***	
				(-3.799)	
ExR Dollar					0.660***
					(3.799)
Venture capital	0.186	0.264	0.264	-0.145	-0.145
	(0.430)	(0.569)	(0.569)	(-0.293)	(-0.293)
Log(1+Age)	-0.129	-0.107	-0.107	-0.335	-0.335
	(-0.875)	(-0.648)	(-0.648)	(-1.261)	(-1.261)
Log(1+Proceeds)	1.579	1.539*	1.539*	1.420	1.420
	(1.633)	(1.666)	(1.666)	(1.147)	(1.147)
R&D	-0.108	-0.121	-0.121	-0.370**	-0.370**
	(-0.808)	(-1.213)	(-1.213)	(-2.355)	(-2.355)
Sales	0.313	0.288	0.288	0.211	0.211
	(0.883)	(0.784)	(0.784)	(0.598)	(0.598)
Log(1+Assets)	0.906***	0.915***	0.915***	0.858***	0.858***
	(3.792)	(4.538)	(4.538)	(4.019)	(4.019)
Top Tier	-0.456	-0.468	-0.468	-0.349	-0.349
	(-1.457)	(-1.518)	(-1.518)	(-1.498)	(-1.498)
N	792	792	792	558	558

4.6. Innovation portfolio and Analysts' Coverage

Loughran and Ritter (2002) argue that analysts' coverage allows the high-prestige investment bankers to attract clients, despite larger underpricing. Most importantly, Liu and Ritter (2011) posit that underwriters with influential analysts have bargaining power which provides

them with the ability to sustain underpricing in equilibrium. In this section, we test whether issuers' innovation portfolios signal to analysts.

Table 9 shows the difference between firms with a bargaining power in terms of analysts' buying and selling recommendations. We define two types of firms with high bargaining power (who experienced upward price revision) and otherwise low bargaining firms (with negative price adjustments). Table 9 shows that bargaining firms are recommended more on average for sale with a higher ExR ratio and Innovation Power. In contrast, the opposite is evident for low bargaining firms with a higher ExT ratio, which are, on average, recommended to buy more stocks. The results are constant over recommendations made within 90 days, 180 days, and 270 days after IPO. Our finding is in a line with the literature, which predicts that analysts recommend selling stocks of an issuer with more valuable innovation and more explorative strategy. For instance, If the firm experiences poor aftermarket stock performance an underwriter-affiliated analyst protects newly public firm in the form of ''booster shots'' of stronger coverage (James and Karceski, 2006).

Next, we test whether the issuer's bargaining power is reflected in analysts' prediction. We posit that when issuers bargain the higher offer price, analysts will not over-forecast.

Table 10 shows the impact of Innovation Power, ExR ratio and ExT ratio on forecast adjustment. Forecast adjustment is actual P/E ratio over forecasted P/E ratio minus one. According to Table 10, ExR ratio is significantly negatively related to analyst forecast. In the same time, ExT ratio is significantly positively related to forecast adjustment. Thus, when issuers with a high ExR ratio negotiated high price during the pre-IPO period, analysts would not over-predict P/E in the post period. In contrast, analysts over predict firms with a high ExT ratio in the post IPO period.

Table 9. Analyst Recommendations and Innovation Strategy. This table shows the difference in innovation strategy between the two types of issuers (with and without Up-Word Price revisions), whose stocks are recommended to sell or buy within 90, 180 and 270 days. Measures of the innovation strategy are independently sorted into price revision portfolios and analyst recommendation portfolios. The price revision portfolios constructed as allocation of innovation measures into those where issuer experienced positive or no price revision. The recommendation portfolios consist of two portfolios Buy and Sell. We classify recommendation as the Buy when analyst issued strong buy or buy recommendation and all the rest recommendations are classified as the Sell. Column (8) reports difference between portfolios, while column (9) reports p-value of t-test for significance of this difference. Analyst recommendations covers the period from 1993 to 2012. The analyst recommendations obtained from I/B/E/S.

	Upward Price Revision				No Upward Revision			
	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)
	Sell270	Buy270	Diff	p-value	Sell270	Buy270	Diff	p-value
Innovation Power	1433.948	462.840	971.108	(0.000)	235.790	268.152	-32.362	(0.33)
ExT	0.492	0.551	-0.059	(0.002)	0.711	0.550	0.161	(0.00)
ExT Dollar	0.499	0.551	-0.052	(0.012)	0.857	0.579	0.278	(0.00)
ExR	0.508	0.449	0.059	(0.002)	0.289	0.450	-0.161	(0.00)
ExR Dollar	0.501	0.449	0.052	(0.012)	0.143	0.421	-0.278	(0.00)
# Recommendations	2822				2211			
	Sell180	Buy180	Diff	p-value	Sell180	Buy180	Diff	p-value
Innovation Power	1483.572	459.814	1023.757	(0.000)	257.255	264.429	-7.174	(0.84)
ExT	0.484	0.554	-0.070	(0.000)	0.673	0.561	0.112	(0.00)
ExT Dollar	0.484	0.559	-0.075	(0.000)	0.829	0.591	0.238	(0.00)
ExR	0.516	0.446	0.070	(0.000)	0.327	0.439	-0.112	(0.00)
ExR Dollar	0.516	0.441	0.075	(0.000)	0.171	0.409	-0.238	(0.00)
# Recommendations	2809				2204			
	Sell90	Buy90	Diff	p-value	Sell90	Buy90	Diff	p-value
Innovation Power	1611.062	459.506	1151.556	(0.000)	290.800	263.267	27.533	(0.48)
ExT	0.478	0.551	-0.073	(0.000)	0.708	0.559	0.149	(0.00)
ExT Dollar	0.466	0.558	-0.092	(0.000)	0.921	0.587	0.334	(0.00)
ExR	0.522	0.449	0.073	(0.000)	0.292	0.441	-0.149	(0.00)
ExR Dollar	0.534	0.442	0.092	(0.000)	0.079	0.413	-0.334	(0.00)
# Recommendations	2772				2151			

Table 10. Analyst P/E Adjustments and Innovation Strategy. This table shows the impact of innovation strategy on the deviation of the Analyst predicted P/E ratio from actual P/E ratio at the end of the period (90, 180 and 270 days after IPO). P/E adjustment (Adj.) is computed as actual P/E ratio over the analysts predicted P/E ratio minus one. The forecasted and actual P/E for the period from 1993 to 2012, obtained from the I/B/E/S. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on Analyst clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Adj.90	**Adj.180**	**Adj. 270**	**Adj.90**	**Adj.180**	**Adj. 270**	**Adj.90**	**Adj.180**	**Adj. 270**	**Adj.90**	**Adj.180**	**Adj. 270**	**Adj.90**	**Adj.180**	**Adj. 270**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Innovation Power	-0.073	-0.003	0.009												
	(-1.155)	(-0.114)	(0.646)												
ExT				0.995***	0.678**	0.937***									
				(2.668)	(2.192)	(2.733)									
ExT Dollar							0.486	0.529	1.152***						
							(1.083)	(1.399)	(2.908)						
ExR										-0.995***	-0.678**	-0.937***			
										(-2.668)	(-2.192)	(-2.733)			
ExR Dollar													-0.486	-0.529	-1.152***
													(-1.083)	(-1.399)	(-2.908)
Venture capital	0.834*	0.767	0.383	0.067	0.316	-0.063	0.298	0.520	0.354	0.067	0.316	-0.063	0.298	0.520	0.354
	(1.786)	(1.582)	(0.631)	(0.131)	(0.547)	(-0.113)	(0.503)	(0.838)	(0.551)	(0.131)	(0.547)	(-0.113)	(0.503)	(0.838)	(0.551)
Log(1+Age)	0.139	0.013	0.015	-0.218	-0.151	-0.179	0.155	0.046	-0.008	-0.218	-0.151	-0.179	0.155	0.046	-0.008
	(0.228)	(0.043)	(0.040)	(-0.386)	(-0.492)	(-0.484)	(0.325)	(0.154)	(-0.022)	(-0.386)	(-0.492)	(-0.484)	(0.325)	(0.154)	(-0.022)
No. of bookrunners	0.425	-0.073	-0.056	0.642	0.132	0.139	0.101	-0.439	0.005	0.642	0.132	0.139	0.101	-0.439	0.005
	(0.783)	(-0.204)	(-0.094)	(1.646)	(0.368)	(0.237)	(0.211)	(-0.952)	(0.005)	(1.646)	(0.368)	(0.237)	(0.211)	(-0.952)	(0.005)
R&D	1.339	0.467	-0.143	1.225	0.564	-0.011	0.650	0.703	-0.747	1.225	0.564	-0.011	0.650	0.703	-0.747
	(1.427)	(1.208)	(-0.276)	(1.547)	(1.605)	(-0.024)	(0.849)	(1.315)	(-1.444)	(1.547)	(1.605)	(-0.024)	(0.849)	(1.315)	(-1.444)
Sales	0.995	-0.449	0.573	1.060	-0.592	0.481	1.081	-0.605	0.572	1.060	-0.592	0.481	1.081	-0.605	0.572
	(0.818)	(-0.653)	(0.740)	(1.015)	(-0.860)	(0.605)	(1.196)	(-0.964)	(0.961)	(1.015)	(-0.860)	(0.605)	(1.196)	(-0.964)	(0.961)
Positive 1d Return	0.518	0.354	0.073	0.012	0.244	-0.102	-0.143	0.232	0.263	0.012	0.244	-0.102	-0.143	0.232	0.263
	(1.101)	(1.144)	(0.139)	(0.028)	(0.774)	(-0.217)	(-0.374)	(0.565)	(0.381)	(0.028)	(0.774)	(-0.217)	(-0.374)	(0.565)	(0.381)
Log(1+Assets)	0.096	0.593**	0.098	-0.008	0.483*	0.031	0.326	0.657**	0.115	-0.008	0.483*	0.031	0.326	0.657**	0.115
	(0.201)	(2.349)	(0.309)	(-0.020)	(1.942)	(0.102)	(0.803)	(2.122)	(0.363)	(-0.020)	(1.942)	(0.102)	(0.803)	(2.122)	(0.363)
N	628	943	1021	628	943	1021	474	745	802	628	943	1021	474	745	802
adj. R-sq	0.102	0.087	0.005	0.139	0.128	0.060	0.181	0.151	0.133	0.139	0.128	0.060	0.181	0.151	0.133
Analyst FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 11. Panel A: Up-Ward Price Revision and Innovation Strategy. The dependent variable in regression is the upward price revision from the midpoint of the initial filing range to the offer price, relative to the midpoint price. The upward price revision is truncated at zero if the price revision takes a negative value. We predict a positive relation between price revisions and the measures of innovativeness of an issuer. Thus, this table reports estimates from the Tobit model with a lower limit of zero. The explanatory variables are Innovation Power, ExR and ExT ratios. Where the ExR (ExT) ratio is the variable that measures the proportion of the cumulative number of Explorative (Exploitative) patents in the total cumulative number of a firm patents at the time of IPO. Innovation Power is a continuous variable greater than 0, which measures an issuer's eleven innovation value portfolios relative to all peers in its technological space. The venture capital variable is an indicator variable taking the value of one if the IPO is backed by venture capital, otherwise it is zero (Venture capital). Age at IPO is log transformation of one plus the number of years since the founding date of the firm (Log(1+Age)) and log transformation of one plus total assets in millions of USD (Log(1+Assets)). Log transformation of one plus proceeds (Log (1+ Proceeds)) defined as the number of shares offered times the share price scaled by total assets in millions of USD. No. of bookrunners is the number of bookrunners responsible for the bookrunner's role. Cumulative expanses on research and development in USD scaled by total assets (R&D). Sales in USD scaled by total assets. The positive first day return variable is an indicatory variable taking the value of one if the first day return is positive, otherwise it is zero (Positive 1d Return). To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Innovation Power	0.005***	0.005***	0.006***						
	(7.624)	(6.947)	(3.890)						
ExT				-0.020***	-0.018***	-0.023***			
				(-4.554)	(-3.412)	(-5.250)			
ExR							0.020***	0.018***	0.023***
							(4.554)	(3.412)	(5.250)
Venture capital	0.083***	0.062***	0.061***	0.083***	0.062***	0.059***	0.083***	0.062***	0.059***
	(4.210)	(3.074)	(4.344)	(4.349)	(3.129)	(4.250)	(4.349)	(3.129)	(4.250)
Log(1+Age)	-0.028**	-0.023*	-0.026**	-0.026**	-0.022*	-0.024*	-0.026**	-0.022*	-0.024*
	(-2.288)	(-1.865)	(-2.011)	(-2.235)	(-1.841)	(-1.923)	(-2.235)	(-1.841)	(-1.923)
Log(1+Proceeds)	0.290***	0.287***	0.274***	0.289***	0.286***	0.274***	0.289***	0.286***	0.274***
	(6.872)	(7.352)	(8.195)	(6.144)	(6.588)	(7.293)	(6.144)	(6.588)	(7.293)
No. of bookrunners	-0.046***	-0.049***	-0.074**	-0.044***	-0.047***	-0.074**	-0.044***	-0.047***	-0.074**
	(-3.253)	(-3.479)	(-2.069)	(-3.183)	(-3.421)	(-2.052)	(-3.183)	(-3.421)	(-2.052)
R&D	-0.202***	-0.205***	-0.184***	-0.190***	-0.195***	-0.174***	-0.190***	-0.195***	-0.174***
	(-3.466)	(-3.668)	(-3.221)	(-3.409)	(-3.623)	(-3.214)	(-3.409)	(-3.623)	(-3.214)
Sales	0.008	-0.004	-0.003	0.007	-0.004	-0.005	0.007	-0.004	-0.005
	(0.412)	(-0.145)	(-0.134)	(0.368)	(-0.147)	(-0.186)	(0.368)	(-0.147)	(-0.186)
Positive 1d Return	0.174***	0.164***	0.167***	0.174***	0.164***	0.168***	0.174***	0.164***	0.168***
	(3.824)	(3.713)	(4.324)	(3.965)	(3.852)	(4.582)	(3.965)	(3.852)	(4.582)
Log(1+Assets)	0.071***	0.072***	0.073***	0.074***	0.075***	0.077***	0.074***	0.075***	0.077***
	(7.030)	(7.453)	(6.430)	(6.639)	(6.978)	(6.216)	(6.639)	(6.978)	(6.216)
Top Tier	0.029*	0.028*	0.025*	0.029*	0.028	0.024*	0.029*	0.028	0.024*
	(1.730)	(1.683)	(1.836)	(1.657)	(1.618)	(1.677)	(1.657)	(1.618)	(1.677)
Walk-Up	0.009	-0.010	-0.052	0.021	0.003	-0.038	0.021	0.003	-0.038
	(0.480)	(-0.572)	(-0.675)	(1.016)	(0.161)	(-0.459)	(1.016)	(0.161)	(-0.459)
N	851	851	851	851	851	851	851	851	851
Industry FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year FE	No	No	Yes	No	No	Yes	No	No	Yes

Table 11 Panel B: Up-Ward Price Revision and Innovation Strategy. The dependent variable in regression is the upward price revision from the midpoint of the initial filing range to the offer price, relative to the midpoint price. The upward price revision is truncated at zero if the price revision takes negative value. We predict a positive relation between price revisions and the measures of innovativeness of an issuer. Thus, this table reports estimates from the Tobit model with a lower limit of zero. This table uses a dollar value of patents from Kogan et al (2015). The dependent variable is price revision. The explanatory variables are ExR(ExT) Dollar ratio. The Positive Adjustment is an indicator variable, which takes a value of one if an issuer experiences positive price adjustment and zero otherwise. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix C. T-statistics in parenthesis are calculated on industry clustered standard errors. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
ExT Dollar	-0.019***	-0.015***	-0.016***			
	(-4.156)	(-3.562)	(-7.056)			
ExR Dollar				0.019***	0.015***	0.016***
				(4.156)	(3.562)	(7.056)
Venture capital	0.077***	0.060***	0.059***	0.077***	0.060***	0.059***
	(5.803)	(4.259)	(5.028)	(5.803)	(4.259)	(5.028)
Log(1+Age)	-0.031**	-0.028*	-0.030*	-0.031**	-0.028*	-0.030*
	(-2.087)	(-1.856)	(-1.863)	(-2.087)	(-1.856)	(-1.863)
Log(1+Proceeds)	0.304***	0.302***	0.288***	0.304***	0.302***	0.288***
	(5.154)	(5.290)	(6.361)	(5.154)	(5.290)	(6.361)
No. of bookrunners	-0.052**	-0.052***	-0.032**	-0.052**	-0.052***	-0.032**
	(-2.512)	(-2.765)	(-2.046)	(-2.512)	(-2.765)	(-2.046)
R&D	-0.167***	-0.172***	-0.145***	-0.167***	-0.172***	-0.145***
	(-3.522)	(-3.656)	(-3.447)	(-3.522)	(-3.656)	(-3.447)
Sales	0.011	-0.001	-0.004	0.011	-0.001	-0.004
	(0.539)	(-0.059)	(-0.155)	(0.539)	(-0.059)	(-0.155)
Positive 1d Return	0.190***	0.182***	0.183***	0.190***	0.182***	0.183***
	(5.530)	(5.580)	(6.634)	(5.530)	(5.580)	(6.634)
Log(1+Assets)	0.082***	0.084***	0.085***	0.082***	0.084***	0.085***
	(5.196)	(5.403)	(4.956)	(5.196)	(5.403)	(4.956)
Top Tier	0.019	0.019	0.022	0.019	0.019	0.022
	(0.990)	(1.049)	(1.378)	(0.990)	(1.049)	(1.378)
Walk-Up	0.010	-0.006	-0.067	0.010	-0.006	-0.067
	(0.633)	(-0.388)	(-0.872)	(0.633)	(-0.388)	(-0.872)
N	742	742	742	742	742	742
Industry FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	No	Yes	No	No	Yes

4.7. Robustness Checks

Our first robustness check follows Ljungqvist and Wilhelm (2003) that looks at only the IPOs that have higher than filing range.

Our second robustness check is on model specification. Instead of having continued measure of price revision, we truncated price revision setting negative values to zero. We then run the tobit model and include the same Innovation Power, ExR and ExT ratios independent variables, as well as the same set of control variables. Results are reported in Table 11. To a large extent, those results are robust to our main results in Table 3

One next robustness check is to follow Brav et al (2016) to add firms that have non-missing R&Ds. In an unreported table, we find out that the results are consistent with our main results in Table 2, Table 3, and Table 4

To assure our main DiD results are valid, we repeat our DiD analysis, but only considering the successfully gone public firms. To a larger extent, our new DiD results confirm the conclusion from Table 7 that more explorative firms tend to seek exploitative innovation projects since they became public.

V. Conclusion

Using a sample of innovative issuing firms from 1986 to 2012, we examine the effects of innovation strategies on IPO pricing. Our primary objective is to examine the effects of an issuer's innovation portfolio on the IPO pricing in terms of two dimensions of the issuer's innovativeness: innovation power and innovation strategy. We contribute to the existing literature in two ways. First, we introduce a measure that captures innovation power relative to its peers in the same

technological space. Second, we explicitly examine the effect of strategic orientation of patent portfolios, in terms of the explorative and exploitative nature of innovations, on IPO underpricing and offer price adjustment.

We show that the US innovative IPOs with higher explorative innovation have higher bargaining power. We conclude that the higher portion of explorative patents in the portfolio can curb underpricing. The higher innovation power is associated with a shorter negotiation process and lower underpricing. We find that bargaining power of an innovative issuer stems from innovation strategies and value of innovation portfolio.

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Appendix A.

Table A1: DLOs and New Issued Debt by Year.

This table summarize DLOs activism by year. We define DLOs as the percentage of newly issued long-term debt that belong to less regulated institutional owners that simultaneously hold both equity and new issued debt in the same entity. We define less regulated institutional owners as institutional investors that do not belong to Pension Fund, Insurance Company or Mutual Fund categories. We derived bond ownership from various fillings since some funds have engaged in activism with less than a 5% ownership in assets of a DLOs company. We determined Bond ownership by using several SEC filings (Schedule 13D and for other owners with beneficial ownership of less than 5% in bonds Schedule 13F and Proxy Statements). The sample includes US MNC that have at least one DLOs event during 2007 to 2014 inclusive. The percentage of shares outstanding held by DLOs denoted as DLO_SH. All variables in Panel A are measured at the event year.

Number of Events	Average amount of new issued debt in billions of USD held by DLOs	DLO_SH
(2)	(3)	(4)
88	1.777	5.43%
71	2.237	4.19%
113	0.191	6.90%
138	0.076	6.42%
179	1.477	4.57%
280	0.122	7.61%
358	8.879	6.93%
57	0.197	8.30%
1284	14.958	6.13%

Table A2. This panel presents average distribution of DEO for each of the Fama-French 12 industries. The percentage of shares outstanding held by DLOs denoted as DLO_SH. This panel shows percentage of equity held by DLOs during whole sample period. The DLO_SH has value of zero for DLOs, which did not hold an equity in year t. The column (1) through (3) describe average DLO_SH for whole sample. The columns (4) through (6) test difference between three years before DLOs and three years after DLOs, while excluding the event year. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	All Years			Difference between three years before and after the event		
Industry	N	Percentage of Main Sample	Mean DLO_SH	Mean After	Mean Before	After - Before
	(1)	(2)	(3)	(4)	(5)	(6)
Consumer nondurables	378	7%	6.17%	8.85%	5.14%	3.71%***
Consumer durables	154	3%	7.21%	11.68%	6.09%	5.59%***
Manufacturing	801	15%	4.98%	6.49%	4.57%	1.93%***
Energy	610	12%	5.78%	7.83%	4.86%	2.97%***
Chemicals	290	5%	5.61%	7.19%	5.04%	2.15%***
Business equipment	851	16%	5.34%	7.58%	5.00%	2.58%***
Telecom	331	6%	6.57%	13.91%	4.00%	9.9%***
Shops	627	12%	6.23%	9.15%	4.77%	4.38%***
Health	501	9%	6.64%	8.53%	5.76%	2.77%***
Other	745	14%	7.10%	9.86%	6.21%	3.65%***
Total	5288	100%	6.16%	9.11%	5.14%	3.96%

Table A3. Panel A: Pre-dual Excess Return and DLOs' Innovation Efficiency. This table reports estimated average innovative efficiency and post activism excess monthly return. The Tables consist of two panels, DLOs firms (Panel A) and Control firms (Panel B). The average slopes estimated following Fama and MacBeth (1973) cross-sectional regressions. The dependent variable is monthly excess return (return with dividends – monthly risk-free rate) in year t+1 and expressed in percentages. Explanatory variables are geometric growth of patent innovation efficiency (GIE Pat), citation innovation efficiency (GIE Cite), scope innovation efficiency (GIE Scope) and geometric growth of total number of patent as well as exploratory number of patents. The explanatory and control variables are measured in year t from 2007 to 2014 and include post activism period. ΔROA is the change in ROA between year t and year t – 1. MTB is market to book assets. CAPX (capital expenditure) and R&D (expenditure on research and development) divided by lagged total assets. Volume is the average daily dollar trading volume from the preceding year. CRet is cumulative average return over the past 12 months skipping the recent month. Industry dummy is based on the Fama and French (1997) 49 industries classification. Average R-squred is the time-series average of the R-squared from the annual cross-sectional regressions. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics (based on adjusted standard errors for heteroskedasticity and serial correlations following Newey and West, 1987) are reported in parenthesis. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)
GIE Pat	1.425***				
	(2.929)				
GIE Cite		-0.130			
		(-1.232)			
GIE Scope			0.685**		
			(2.187)		
GPat				0.478**	
				(2.139)	
GExplore					0.420***
					(5.297)
Log(1+ME)	0.085	0.093	0.101	-0.183	0.069
	(0.332)	(0.364)	(0.391)	(-0.886)	(0.269)
Volume	0.000	0.000	0.000	-0.000	0.000
	(1.579)	(1.554)	(1.562)	(-0.250)	(1.252)
M/B	0.309***	0.309***	0.308***	0.243***	0.310***
	(3.682)	(3.689)	(3.666)	(3.595)	(3.690)
ΔROE	-0.031	-0.034	-0.031	-0.042	-0.031
	(-1.159)	(-1.251)	(-1.135)	(-1.582)	(-1.142)
R&D	-11.977***	-11.236***	-11.604***	-11.363***	-13.795***
	(-4.561)	(-4.295)	(-4.460)	(-4.184)	(-4.867)
CAPX	-8.910***	-8.940***	-8.894***	-8.986***	-8.734***
	(-3.728)	(-3.695)	(-3.778)	(-3.812)	(-3.659)
IO	0.016	0.016	0.016	0.037***	0.017
	(1.230)	(1.217)	(1.204)	(3.018)	(1.294)
CRet	1.734***	1.747***	1.732***	1.971***	1.760***
	(3.118)	(3.162)	(3.114)	(3.574)	(3.186)
ΔTA	1.222	1.309	1.298	1.291	1.359
	(1.260)	(1.368)	(1.356)	(1.350)	(1.424)
R-sq	0.370	0.370	0.370	0.370	0.372

Table A3. Panel B: Pre-dual Excess Return and Controls' Innovation Efficiency.

This table reports estimated average innovative efficiency and post activism excess monthly return for control firms. The average slopes estimated following Fama and MacBeth (1973) cross-sectional regressions. The dependent variable is monthly excess return (return with dividends – monthly risk-free rate) in year t+1 and expressed in percentages. Explanatory variables are geometric growth of patent innovation efficiency (GIE Pat), citation innovation efficiency (GIE Cite), scope innovation efficiency (GIE Scope) and geometric growth of total number of patent as well as exploratory number of patents. The explanatory and control variables are measured in year t from 2007 to 2014 and include post activism period. ΔROA is the change in ROA between year t and year t – 1. MTB is market to book assets. CAPX (capital expenditure) and R&D (expenditure on research and development) divided by lagged total assets. Volume is the average daily dollar trading volume from the preceding year. CRet is cumulative average return over the past 12 months skipping the recent month. Industry dummy is based on the Fama and French (1997) 49 industries classification. Average R-squred is the time-series average of the R-squared from the annual cross-sectional regressions. To dilute the influence of outliers, all variables are winsorized at the 1st and 99th percentiles. All variables are defined at Appendix B. T-statistics (based on adjusted standard errors for heteroskedasticity and serial correlations following Newey and West, 1987) are reported in parenthesis. Upper-asterisks such as *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)
GIE Pat	-7.736***				
	(-3.466)				
GIE Cite		-1.045***			
		(-4.240)			
GIE Scope			0.881		
			(1.569)		
GPat				-0.016***	
				(-4.052)	
GExplore					0.869**
					(2.553)
Log(1+ME)	0.475**	0.466**	0.502**	0.427**	0.422**
	(2.452)	(2.500)	(2.578)	(2.228)	(2.182)
Volume	-0.000**	-0.000**	-0.000**	-0.000*	-0.000*
	(-2.166)	(-2.099)	(-2.088)	(-1.980)	(-1.914)
M/B	0.140***	0.123**	0.131***	0.127**	0.103**
	(2.772)	(2.581)	(2.743)	(2.607)	(2.212)
ΔROE	-0.064	-0.063	-0.052	-0.057	-0.050
	(-1.602)	(-1.599)	(-1.256)	(-1.395)	(-1.257)
R&D	-9.446**	-8.736**	-10.111***	-10.120***	-11.120***
	(-2.633)	(-2.601)	(-2.799)	(-2.698)	(-2.897)
CAPX	11.167***	10.875***	10.102***	11.057***	10.650***
	(3.935)	(3.975)	(3.563)	(3.899)	(3.712)
IO	0.002	0.003	0.002	0.003	0.002
	(0.133)	(0.220)	(0.183)	(0.290)	(0.131)
CRet	0.929**	0.913**	0.975**	0.978**	0.990**
	(2.065)	(2.012)	(2.158)	(2.180)	(2.195)
ΔTA	1.545	1.635	1.625	1.775	1.723
	(1.323)	(1.452)	(1.415)	(1.489)	(1.479)
R-sq	0.291	0.291	0.291	0.292	0.293

Table A4. Panel A: Pre-Dual Exploration Strategy (ES) and Risk Factor Models. This table illustrates the capability of ES to predict the risk adjusted return. We first sort firms into small (S) and big (B) based on the NYSE median size break points. We also perform further sort into Low(L), Medium (M) and High (H) values of ES based on 70 and 30 percentiles over three years following the event in year t. Then we hold portfolio over three years starting at the end of June of year t-3 (Panel A, three-year pre-event window) and t+1(Panel B, three-year post-event window) and compute the monthly size adjusted value-weighted return for the both periods. We adjust the monthly value-weighted return as taking average of Big (B) and Small (S) within each of ES group (e.g. (S/L+B/L)/2, (S/M+B/M)/2, (S/H+B/H)/2). This table reports average excess return in percentages (columns 1 and 2), alpha (α) from Carhart four-factor model (column 4 and 5) and alpha (α) from Fama-French three factor model (columns 7 and 8). The columns (6) and (9) reports difference in alpha between DLOs and Control firms. The excess return is defined as difference between value-weighted size adjusted monthly return and the one-month Treasury bill rate. The excess return and alpha are expressed in percentages. We use the following factors: MOM, the momentum factor of Carhart (1997); MKT, HML, SMB factors of Fama and French (1993); ES is computed as the ratio between number of explorative patents at time t and total number of patents at time t. Patent used new knowledge about the benchmark. The benchmark is computed as the median value of new knowledge used by its peers in the same technological class in the same year t. We measure new knowledge by citation outside of an inventor's current expertise (technological classes). Robust t-statistics, computed following Newey and West (1987) using six legs, are presented in parentheses.

	Excess Return			Carhart four-factor model			Fama-French three factor model		
	DLOs	Control	DLOs-Control	DLOs (α)	Control (α)	DLOs-Control	DLOs (α)	Control (α)	DLOs-Control
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Low	1.527***	1.722***	-0.195	0.141	0.247**	-0.106	0.145	0.253***	-0.109
	(15.087)	(18.395)	(-1.418)	(1.238)	(2.509)	(-0.849)	(1.277)	(2.589)	(-0.872)
Medium	0.738***	0.879***	-0.141	-0.069	-0.195	0.126	-0.103	-0.189	0.086
	(6.402)	(6.562)	(-0.798)	(-0.355)	(-0.706)	(0.366)	(-0.513)	(-0.686)	(0.251)
High	1.284***	1.3548***	-0.071	0.043	-0.115	0.158	0.027	-0.126	0.153
	(11.664)	(12.547)	(-0.459)	(0.212)	(-0.878)	(0.672)	(0.135)	(-0.961)	(0.658)
H-L	-0.243***	-0.368***	0.125	-0.098	-0.361**	0.264	-0.118	-0.379**	0.262
	(-2.796)	(-5.828)	(1.161)	(-0.431)	(-2.312)	(0.999)	(-0.517)	(-2.416)	(0.999)

Table A4. **Panel B. Post-Dual Exploration Strategy (ES) and Risk Factor Models.** The excess return, alpha and loading factors are expressed in percentages. This panel reports excess return and risk-adjusted return form the explorative strategy. ES is computed as the ratio between number of explorative patents at time t and total number of patents at time t. Patent used new knowledge about the benchmark. The benchmark is computed as the median value of new knowledge used by its peers in the same technological class in the same year t. We measure new knowledge by citation outside of an inventor's current expertise (technological classes). Robust t-statistics, computed following Newey and West (1987) using six legs, are presented in parentheses.

	Excess Return			Carhart four-factor model			Fama-French three factor model		
	DLOs	Control	DLOs-Control	DLOs (α)	Control (α)	DLOs-Control	DLOs (α)	Control (α)	DLOs-Control
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Low	1.439***	1.616***	-0.178	-0.276***	-0.358***	0.082	-0.279***	-0.358***	0.079
	(12.284)	(15.774)	(-1.142)	(-3.030)	(-4.866)	(1.152)	(-2.848)	(-4.838)	(1.045)
Medium	1.326***	0.653***	0.673***	0.025	-0.845***	0.870***	0.024	-0.849***	0.873***
	(11.758)	(3.385)	(3.011)	(0.202)	(-3.338)	(3.252)	(0.199)	(-3.310)	(3.232)
High	1.823***	1.354***	0.469***	0.465***	-0.288***	0.753***	0.465***	-0.289***	0.754***
	(15.025)	(12.483)	(2.884)	(2.979)	(-3.165)	(4.539)	(2.981)	(-3.160)	(4.549)
H-L	0.385***	-0.262***	0.647***	0.741***	0.070	0.671***	0.745***	0.070	0.675***
	(5.165)	(-5.489)	(7.311)	(3.822)	(0.526)	(3.679)	(3.789)	(0.526)	(3.649)

Appendix B.

Variable	Definition
DLO_SH	The percentage of shares outstanding held by dual less regulated owners (DLOs) in year t.
IO	Year-end fraction of shares held by institutional investor in year t.
LRF/TSO	The shares held by less regulated funds (LRF) as the percent of total shares outstanding (TSO).
Size	Log transformation of one plus total assets (publicly traded foreign subsidiary assets)
Cash /Total Assets	Cash plus marketable securities (CHE) scaled by total assets at the beginning of the fiscal year.
Leverage	Ratio of Total Debt to Total Asset
Dividend-paying firms/total # of firms	Number of US MNCs, which at least once paid dividends during sample period scaled by total number of US MNCs.
Domestic (foreign) profit margin	The domestic (foreign) profit margin is calculated as the ratio of domestic (foreign) net income over domestic (foreign) sales.
FPI/TI	Pre-tax Income foreign (FPI) scaled by total income (TI).
THS/TFS	# of foreign subsidiaries (TFS) scaled by # tax haven subsidiaries (THS). If no information is reported we set # of subsidiaries in tax haven countries to zero. Both variables come from 10-k filings.
MTB	The ratio of the market value of equity to book value of equity in year t.
EBITDA	The amount of earnings before income taxes, depreciation and amortization at year t scaled by total assets.
FCF	This variable is computed as net cash flow from operating activities less dividends paid and capital expenditures in year t.
Div/E	This variable represents ratio of dividends per share to earnings per share. This measure is yearly and compute for each year t.
CAPX	Measured at the end of the fiscal year as capital expenditure scaled by total assets in year t.
Age	Log transformation of one plus company i's age. Company i's age in year t equals to the number of years the corporation has existed since the founding year.
R&D	R&D expenses divided by total assets in year t.
CR	CR is cumulative average return over the past 12 months skipping the recent month.

Appendix B Continued

Investment Delay	Hoberg & Maksimovic (2014) text based continuous measure of a firm overall financial constraint due to delay in investment. The higher value of a dependent variable shows that a firm is more similar to a set of firms known to be at risk of liquidity issues.
Equity Delay	Hoberg & Maksimovic (2014) text based continuous measure of a firm overall financial constraint due to delay in investment. The higher value of a dependent variable shows that a firm is more similar to a set of firms known to be at risk of liquidity issues and presumes solving this delay by issuance of equity.
Debt Delay	Hoberg & Maksimovic (2014) text based continuous measure of a firm overall financial constraint due to delay in investment. The higher value of a dependent variable shows that a firm is more similar to a set of firms known to be at risk of liquidity issues and presumes solving this delay by issuing new debt.
Private Placement	Hoberg & Maksimovic (2014) text based continuous measure of a firm overall financial constraint due to delay in investment. The higher value of a dependent variable shows that a firm is more similar to a set of firms known to be at risk of liquidity issues and presumes solving this delay by private placement.
ISP	The total amount of stock purchased by an insider at year t scaled by total assets.
ISS	The total amount of stock sold by an insider at year t scaled by total assets.
IS	Insider Ownership measured as percent of stock held by insiders relative in total shares outstanding in year t.
CV	CV is an indicator variable that takes value of 1 if information about a firm covenant violation is available in the dataset of Roberts and Sufi, (2009). The dataset contains all covenants violation filed with SEC during 1996 to 2012.
Vict	An indicator variable that takes the value of one if a shareholder activist partially or fully won a proxy fight and zero otherwise.
Vict Part	An indicator variable that takes the value of one if a shareholder activist partially won a proxy fight and zero otherwise.
Vict Full	An indicator variable that takes the value of one if a shareholder activist fully won a proxy fight and zero otherwise.
Settle	An indicator variable that takes the value of one if a proxy fight ended in settlement and zero otherwise.
CBoard	An indicator variable that takes the value of one if a firm implemented the classify (staggered) board and zero otherwise.
Bylaw	An indicator variable that takes the value of one if a firm implemented the Bylaw provision and zero otherwise.
Poison Pills	An indicator variable that takes the value of one if a firm implemented poison pills and zero otherwise.

Appendix B Continued	
Golden Parachute	An indicator variable that takes the value of one if a firm implemented golden parachute and zero otherwise.
Pat(Fpat)	Pat is log transformation of one plus patent counts, where patent counts are constructed following Bena and Li (2014) as number of awarded patents to firm i in technology class k with application year t scaled by the median value of granted application corresponding to firm's i technology class and application year. Pat is aggregated at the parent level. Fpat constructed in the similar manner as the Pat but aggregated at the foreign level.
Cite(Fcite)	Cite is log transformation of one plus the number of citations received scaled by the median value of received citations in corresponding to firm's i technology class and application year. Cite is aggregated at the parent level. Fcite is constructed in the same manner as the Cite but with aggregation at the foreign level.
Scope(Fscope)	Patent scope is the number of unique four digits classes of International Patent Classification (IPC) in a given patent documentation relative to the maximum scope in the same IPC class and application year. The higher patent scope, the higher is the market value of a patent. The scope is aggerated at the parent level. FScope is constructed in the same manner but with aggregation at the foreign level.
IE Pat (IE FPat)	Following Hirshleifer et al (2013), IE_pat is constructed as patents count scaled by cumulative R&D over past five years with 20%. This measure is aggregated at the US MNCs (foreign) level.
IE Cite (IE FCite)	Following Hirshleifer et al (2013), IE_cite is constructed as the sum of citation received during last five years scaled by cumulative legged R&D over past five years starting t-3. This measure is aggregated at the US MNCs (foreign) level.
IE scope (IE FScope)	IE_scope is constructed as the patent scope scaled by cumulative legged R&D over past five years starting t-3. This measure is aggregated at the US MNCs (foreign) level.
GIE Pat (%)	Three-year geometric growth in patent innovation efficiency (GIE Pat).
GIE Cite (%)	Three-year geometric growth in citation innovation efficiency (GIE Cite).
GIE Scope (%)	Three-year geometric growth in scope innovation efficiency (GIE Scope).
GPat (%)	Three-year geometric growth in patent counts.
GExplore (%)	Three-year geometric growth in exploratory number of patents. A patent i is categorized as "explorative" if the percentage of citations made, which correspond to the outside of firm i's existing expertise, is greater than the 80%.
Completion FA	The successfully completed foreign acquisition as a percent of total number of acquisitions in year t.
Completion DA	The successfully completed domestic acquisition as a percent of total number of acquisitions in year t.

Appendix B Continued	
Completion Focused FA	The successfully completed focused acquisition as a percent of total number of acquisitions in year t. An acquisition defined as a focused based on equivalence of a DLOs's and an acquirer's three-digits SIC code.
Premium 7d Px Completed DA	Acquisition premium with respect to the DLOs's average stock price 7 days prior to the foreign acquisition announcement.
Premium 7d Px Completed FA	Acquisition premium with respect to the DLOs's average stock price 7 days prior to the domestic acquisition announcement.
Premium 7d Px Focused Acq.	Acquisition premium with respect to the DLOs's average stock price 7 days prior to the foreign focused acquisition announcement. An acquisition defined as a focused based on equivalence of a DLOs's and an acquirer's three-digits SIC code.

Appendix C

Variables	Definitions
	IPO
Underpricing	Defined as the first day return: the first day closing price over initial offering price, minus one. Formula: (1st Day Closing Price - Initial Offering Price)/Initial Offering Price. Prices obtained from SDC. If the first day closing price is missing it is replaced with the value from CRSP.
Price Revision	Following Bradley et al (2015) we define the price revision as difference between the final offer price and the mid-price of original file range with further division the difference by the mid-price of original file range. Midpoint price ranges are from SDC. Missing midpoint price ranges are replaced with values from Bloomberg.
Up-Revision	Following Ljungqvist and Wilhelm, (2003), the Up-Revision is equal to price revision if the difference between the midpoint of the filing price range and the final offering price is positive, and zero otherwise
Positive Adjustment	The Positive Adjustment is an indicator variable, which takes value of one if an issuer experiences positive price adjustment and zero otherwise.
Speed-of-IPO	The Speed-of-IPO is defined as the difference between the IPO date and the first filling date of IPO prospectus.
N. of Bookrunners	The number of bookrunners defined as the number of managers with the responsibility of the bookrunner's role.
Walkup	The indicator variable, which takes value of one if year corresponds to year of an underwriter walkup strategy such as 1999 or 2000.
Adj.	The Analyst predicted P/E ratio from actual P/E ratio at the end of period (90, 180 and 270 days after IPO). P/E adjustment (Adj.) is computed as actual P/E ratio over the analysts predicted P/E ratio minus one.
Buy (Sell)	Buy is an indicator variable if an Analyst made strong buy or buy recommendation stock within 90,180 and 270 days after IPO and zero otherwise. In contrast, Sell is an indicator variable that take value of one if an Analyst makes hold, sell or strong sell recommendation and zero otherwise.
	Innovation
Innovation Power	Innovation power is distance of firm' eleven innovation portfolios relative to its technological space. The detailed discussion of this variable presented in the Section 3.1.
Patents ExR	This measure represents cumulative sum of firm i the number of explorative patents for pre-ipo period. A patent i is categorized as "explorative" if the percentage of citations made, which correspond to the outside of firm i's existing expertise, is greater than the median value of the existing expertise of corresponding technological class.

Appendix C Continued	
Patents ExT	This measure represents cumulative sum of firm i the number of exploitative patents for pre-ipo period. A patent i is categorized as "exploitative" if the percentage of citations made, which correspond to the outside of firm i's existing expertise, is lower than the median value of the existing expertise of corresponding technological class.
ExR	Ratio of the cumulative number of explorative patents (ExR) to the total cumulative number of a firm patents at the time of IPO (Patents).
ExT	Computed as one minus ratio of the explorative ratio (*ExR Ratio*).
ExR (ExT) Dollar	Constructed similar to the ExR (ExR) Ratios but instead of using patent quantity, Kogan's et al (2015) Dollar value of a patent is used.
Patents	This variable represents cumulative sum of patent counts at time of IPO. Where patent counts are constructed as number of awarded patents to firm i in technology class k with application year t. Next, sum all patents of firm i up to time of firm i's IPO.
Firm Characteristics	
Age at IPO	Defined as the natural log transformation of the one plus the difference between the calendar year at the time of IPO and the firm founding year (in years). Formula: log (1+ number of years since the firm founding date).
Assets	Defined as the natural log transformation of one plus total assets at the time of IPO (in $millions).
Proceeds	Defined as the natural log transformation of one plus IPO proceeds. IPO proceeds is the amount raised during IPO from investors and calculated as the offer price times number of shares offered at the time of IPO (in $millions).

Appendix C continued	
R&D	Defined as the cumulative sum of expenses on research and development made by the firm during pre-IPO period, scaled by total assets at time of IPO (in $millions). Main values are obtained from COMPUSTAT. Missing values are replaced by ones from Bloomberg.
Sales	Defined as the total sales scaled by firm's total assets at the time of IPO. Values are obtained from COMPUSTAT. Missing values are replaced with the ones form Bloomberg.
Venture Capital	The venture capital variable is an indicator variable that takes the value of one if the IPO is backed by venture capital, otherwise it is zero.

Appendix D.

Pairwise Correlation Matrix of Innovation Measures. P-value reported below correlation coefficients in the parenthesis.

	Patents	*Patents ExR*	*Patents ExT*	*Innovation Power*	*ExT*	*ExT Dollar*	*ExR*	*ExR Dollar*	*R&D*
Patents	1								
Patents ExR	0.5286	1							
	(0.000)								
Patents ExT	0.7082	0.2398	1						
	(0.000)	(0.000)							
Innovation Power	0.2541	0.1852	0.2311	1					
	(0.000)	(0.000)	(0.000)						
ExT	0.132	-0.4581	0.4273	0.0096	1				
	(0.000)	(0.000)	(0.000)	(0.752)					
ExT Dollar	0.1335	-0.4466	0.4106	0.0455	0.984	1			
	(0.000)	(0.000)	(0.000)	(0.168)	(0.000)				
ExR	-0.132	0.4581	-0.4273	-0.0096	-1	-0.984	1		
	(0.000)	(0.000)	(0.000)	(0.752)	(0.000)	(0.000)			
ExR Dollar	-0.1335	0.4466	-0.4106	-0.0455	-0.984	-1	0.984	1	
	(0.000)	(0.000)	(0.000)	(0.168)	(0.000)	(0.000)	(0.000)		
R&D	0.1432	0.0405	0.1339	0.1201	0.0565	0.0794	-0.0565	-0.0794	1
	(0.000)	(0.180)	(0.000)	(0.000)	(0.061)	(0.016)	(0.061)	(0.016)	

Vita

The author was born in L'viv, Ukraine. He received his bachelor of science in finance from Ivan Franko L'viv National University, 2003. He has over ten years' experience in banking industry as well as about 2 years' experiences in IT and non-profit industries. In 2011, He received master degree of business administration from Eastern Washington University. He advanced his education at the University of New Orleans, where he obtained master of science (2015) and doctor of philosophy (2018) in financial economics.